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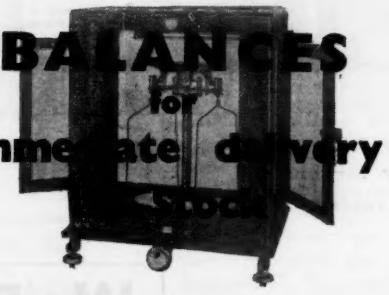

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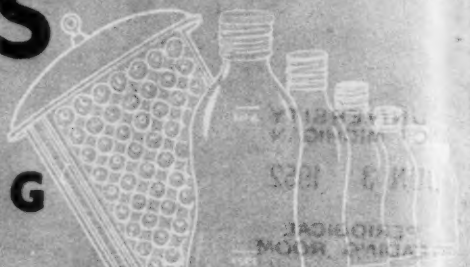

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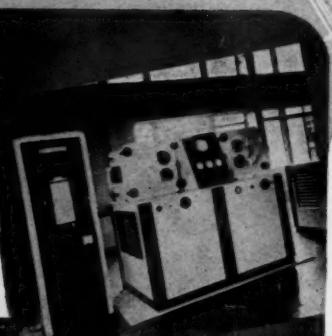

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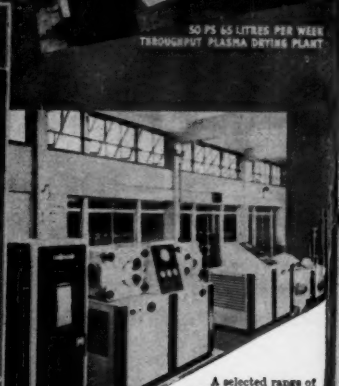

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NATURE

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THE RAY SOCIETY

AT no time in the history of publishing has the number of books devoted to natural history formed so large a percentage of the total output as in the years since the War ended. Some of these are of indifferent quality ; but on the whole the standard is good, and in some instances very high. Furthermore, the demand for this type of book shows little sign of slackening. This is surely a thing that would have delighted the heart of Dr. George Johnston, yet, paradoxically, it makes even more necessary the aim for which he worked.

Johnston, who died in 1855, lived at Berwick-on-Tweed, a doctor by profession and a naturalist by hobby. He realized that with the growing interest in science, and especially in natural history, there was a need for publishing works of merit devoted to the British flora and fauna that were too large for inclusion in the pages of scientific periodicals yet had not sufficient appeal to the commercial publisher. In 1844, as the result of his energy and drive, the Ray Society was founded, named in honour of John Ray, the most renowned of early English naturalists, who died in 1705. In this, Johnston was helped by other distinguished naturalists, such as Sir William Jardine, Edward Forbes, Richard Owen and J. S. Bowerbank. A brief circular was drawn up, explaining the aims of the proposed society, and sent to those likely to be interested. Within a year 650 members were enrolled.

In the 108 years of its existence, the Ray Society has issued 136 volumes, representing a contribution of roughly a hundred thousand books devoted to the study of British natural history. The magnitude of this achievement is the greater since in no instance has the Society published a second edition. The field covered by these volumes is wide, and includes monographs on Rhizopoda, Foraminifera, Sponges, Sea-anemones, Hydroids, Annelids, Cirripedes, Copepods, Mysids, Spiders, Mites, Insects, Amphibia, Whales, Desmids, Charophyta, Lichens and so on. In other words, the existence of the Society has made possible the publication of works that would almost certainly not otherwise have seen the light of day. A fair proportion of these have become standard works of reference ; and some are the only books on their subject, invaluable even if out-of-date. The debt which British natural history owes to Johnston and to the Ray Society is therefore a heavy one.

Like all societies, the Ray Society has had its ups and downs. By 1847 its membership had reached the figure of 868, in 1849 it was down to 805, and from then on a steady decline took place. The First World War saw the membership drop to 258, and between that and the Second World War it hovered uneasily around the 200 mark and in 1941 had dropped to 171, and of this number the great majority were libraries. In view of the falling value of the pound sterling during the century, and the fact that the annual subscription stood, and still stands, as in 1844 at one guinea, the loss in membership constituted a severe financial blow. Yet at no time has the Society failed to produce its volumes,

thanks to generous private benefactions, although in 1941 it was seriously debated whether the Society should be wound up.

Apart from the many informed amateurs, the lists of members issued periodically contain such famous names as Darwin, Huxley, Avebury, Hooker, Gould, Lyell, Yarrell, Stainton and Charles Kingsley. The Prince Consort himself was a subscriber, and his name heads the list for 1860. In addition, many members of the nobility gave their patronage to the Society, and their names on the lists of membership add colour, if no more, to its history. They serve, together with the high hopes with which the Society began and its later considerable achievement, to emphasize the lamentably low ebb reached in the years between the Wars.

Much of the need felt by Johnston and his collaborators is met to-day by certain well-known commercial publishers who constitute formidable competitors to the Ray Society publications. They create the greater need for volumes on obscure groups, in order to keep the total of our knowledge even, and tend to attract authors of works having a more general appeal away from the Ray Society. Nevertheless, in spite of past misfortunes, the effects of two World Wars, rising costs of production, the static condition of the subscription and other adverse circumstances, the fortunes of the Society seem to be following an upward trend. This is due first and foremost to the magnificent support given in recent years by Messrs. Imperial Chemical Industries, Ltd., the value of which cannot be over-stated. There are, however, other satisfactory features to record. The gap caused by the suspension of activity during the last War is being made good, and the time-lag in the issue of volumes is being reduced. Membership is on the increase and now stands at 431. This is satisfactory, but is still less than half of the peak reached in 1847, although the population of Britain and the actual number of people interested in natural history in this country have increased considerably. There is, also, an encouraging increase in the sales of previous volumes. One result is that the list of volumes out-of-print or in extremely short supply is growing. It also creates the need for replacing these by works from modern authors.

The future of the Society appears bright and, among other things, a sufficient number of manuscripts are promised to guarantee the yearly issue of volumes for the next few years at least. The moment seems opportune, therefore, to emphasize the advantages to the systematist and the ecologist of a Society which provides facilities for publishing their monographs, and to both these and to the general naturalist of being able to acquire authoritative works on extremely reasonable terms. It is hoped that the projected publication of a "History and Bibliography of the Ray Society", by Richard Curle, may help to make these things more widely known. In the meantime, the Honorary Secretary, The Ray Society, c/o British Museum (Natural History), London, S.W.7, will be pleased to give further information on the Society's activities.

MICROBIAL GENETICS AND BIOCHEMISTRY

The Genetics of Micro-organisms

By D. G. Catcheside. Pp. vii+223. (London: Sir Isaac Pitman and Sons, Ltd., 1951.) 21*s*. net.

MICRO-ORGANISMS have been used in genetic investigations on an ever-increasing scale during recent years. The reasons why they are preferred to other organisms are threefold: their rapid life-cycle; the fact that they generally can be studied in the haplophase as well as in the diplophase; and the possibility of tetrad analyses in many micro-organisms, which enables a much more detailed study of the results of meiosis than is possible in higher organisms. The characters investigated are partly morphological, but also biochemical, and one has the feeling, therefore, that by studying the genetics of these organisms one gets closer to an understanding of the real nature of inheritance and mutation.

Many geneticists will be indebted to Prof. D. G. Catcheside for having collected in this book the essential facts relating to our present knowledge of the genetics of micro-organisms. Prof. Catcheside is an all-round and distinguished cytogeneticist, so the theme is in good hands.

It is not at all easy to classify the contents according to a satisfactory principle. Should the topics be classified according to the phenomena or through a systematic survey of the organisms? Prof. Catcheside has chosen (and this may probably be called the book's weak point) a combination of both principles. Following an introduction in Chapter 1, he treats in Chapter 2 the genetic analysis of *Neurospora* and other fungi. Chapter 3 deals with mutation and gene action, Chapter 4 with adaptation and mutation, and Chapter 5 with sexual reproductive systems. After this the author returns in the last four chapters to the different taxonomic classes—yeasts, protozoa, bacteria and viruses, respectively. The last-named are regarded as true parasitic organisms "by extension of the definition of the term 'cell'". Although the classification thus cannot be called logical, it must be admitted that scarcely any other principle of classification would be entirely satisfactory.

It appears from this that *Neurospora* has been chosen as a paradigm of the inheritance of micro-organisms, and it cannot be questioned that this fungus to-day takes up about the same position within the lower organisms as *Drosophila* within the higher. No other micro-organism has been the object of so many and fruitful experiments. Chapter 2 gives a good survey of the distribution of genes in ordered tetrads. Chapter 3 (mutation and gene action) is a direct continuation of Chapter 2 in so far as it deals almost exclusively with *Neurospora*, in which the already now classical biochemical mutants are the subject of a thorough discussion.

In Chapter 4 (adaptation and mutation) *Neurospora* again is the main object, while adaptation and mutation in other micro-organisms—for example, bacteria and yeasts—are postponed to the later chapters dealing with these organisms. The author regards (p. 78) induced mutations as practically always being of a more or less destructive nature, and he adds that "the induction of progressive changes is hardly to be expected at least with X-rays". The literature, however, shows cases in

which, for example, a non-fermenting type has been changed to a fermenter without the mutation of an inhibitor gene being the explanation. On the whole, it is not always possible to decide whether a mutational change is to be regarded as a destruction or a progression, as, for example, when one mating type mutates to another, or when a homothallic type mutates to a heterothallic. Most analysed mutants in *Neurospora* are deficient as regards the ability to synthesize certain vitamins or amino-acids, and this fact apparently stamps the author's views on the nature of the biochemical mutants in general. When he states (p. 78) that "The biochemical deficiency mutations are by their very nature lethal to the organism, which is able to live only if the loss is made up by an external supply of the deficient substance", this is not valid for deficiencies as to fermentation enzymes.

In Chapter 5 (sexual reproduction systems) Prof. Catcheside discusses in a very instructive way dioecism, relative sexuality and compatibility genes, and the chapter ends with a section on parasitism in which the following statement (p. 108) is of a special interest, even if the author does not regard the matter as conclusively settled: "It appears to be a general rule that susceptibility of a host is genetically recessive to resistance of the host to a given pathogenic race of a fungus. It also appears usual for the virulence of a fungus with respect to a given host variety to be recessive to avirulence". Prof. Catcheside considers the possibility that the dominant type is able to synthesize a substance which counteracts the attack of the parasite. Chapters 6–9 deal with yeasts, protozoa, bacteria and viruses, respectively, giving short and good surveys of our present knowledge of their genetics. As to yeast fungi, the author seems not to have observed that homothallic forms are common within the genus *Saccharomyces*. Among the protozoa it is, of course, *Paramecium*, and among the bacteria, *Escherichia coli*, which are the main objects of the treatment. The genetics of these organisms present very interesting phenomena indeed.

For some unexplained reasons Prof. Catcheside has not used the classical designation of the genes, using small letters also for the dominant alleles; thus he writes a^+b^+ instead of *AB* and lac^+ for *Lac*. This makes the formulæ rather less legible. Ö. WINGE

PHOTOSYNTHESIS AND RELATED PROCESSES

Carbon Dioxide Fixation and Photosynthesis

(Symposia of the Society for Experimental Biology, No. 5: Published for the Company of Biologists on behalf of the Society for Experimental Biology.) Pp. vii+342. (Cambridge: At the University Press, 1951.) 42*s*. net.

THIS volume, which prints the papers given in 1950 at the meeting in Sheffield of the Society for Experimental Biology, follows after only one year a similar monograph published by the American Society of Plant Physiologists. It contains much information not available in the earlier volume, but so rapid is the advance in our knowledge of photosynthesis that already yet more recent reviews have been published by four contributors to this volume, and new contributions of importance briefly mentioned by Ochoa and by Burk are now published in detail. In spite of this rapid progress, the volume represents for the specialist a convenient collection of valuable papers covering a wide range of aspects of photosynthesis.

The first chapters, contributed by Krebs, Ochoa, Wood and Herbert, deal with mechanisms of carbon dioxide fixation in animal tissues and in bacteria, omitting, however, any discussion of formic dehydrogenase. The main discussion concerns the relationship between malate enzyme and oxalacetate β-carboxylase, and Herbert's paper is perhaps the clearest introduction to this at present confusing subject. Ochoa gives experimental details of the preparation and activity of malate enzyme, while Wood reports new information concerning the carboxylase. Since the rest of the volume is chiefly concerned with photosynthesis, it is surprising to find no contribution concerning the distribution of these enzymes in higher plants.

Another group of papers directs attention to some aspects of photochemistry relevant to photosynthesis. Evans and Uri discuss photochemical reactions of metal ions, and Weiss formulates mechanisms of some photochemical reactions involving photolysis of water. Bowen contributes a clearly written account in general terms of the nature of fluorescence, and Franck briefly re-states his views on the relationship between the fluorescence of chlorophyll in the plant and photosynthesis.

Studies in comparative biochemistry are quoted by Wassinck as evidence for the view that the function of light in photosynthesis is the production of general reducing power, while Hill is more cautious in his account of the water-splitting tendency of illuminated chloroplasts. French and Milner report further observations on the reactions of fragmented chloroplasts. Calvin and co-workers contribute a speculative, but stimulating, discussion of their work with carbon-14; Gaffron, Fager and Rosenberg now report agreement with Calvin's claim that phosphoglyceric acid is the first compound labelled during illumination but do not agree with his observations or interpretation of the dark-fixation following preillumination. Both the latter papers discuss possible mechanisms of photosynthesis in biochemical terms, an approach to the problem first suggested by Van Niel and now showing promise of development beyond its present largely hypothetical level through further work with carbon-14 and with isolated chloroplasts.

Agreement has not been reached as to the maximum observable energetic efficiency of photosynthesis in short alternate periods of light and dark. Warburg and Burk claim to observe an efficiency of 4 quanta per oxygen molecule; but Nishimura, Whittingham and Emerson interpret these observations differently, pointing out the various assumptions made concerning the validity of the two-vessel method employed. (In the latter paper the equations on pp. 185–186 are printed incorrectly.) In this connexion, Kok contributes some observations upon the relationship between respiration and photosynthesis.

Some studies in traditional plant physiology complete the volume. Thomas discusses the changes in titratable acid in *Bryophyllum* leaves and suggests a mechanism of acid formation. Penman and Schofield present fundamental ideas concerning diffusion of water vapour and carbon dioxide in the land leaf with reference to observations on yield and water loss of a crop plant; and Heath reports investigations of photosynthesis when gas is forced

through the intercellular spaces at a rate independent of stomatal aperture.

Such a wide range of topics, which must eventually be co-ordinated in an understanding of photosynthesis, may confuse the non-specialist, particularly as the arrangement is not such as to emphasize their interrelationship. The reader will miss the informal discussions which add greatly to any meeting; and I regret that in this series, and in this volume in particular, no general editor is appointed to consider the contents of each volume as a whole and to supply an introductory survey for the guidance of the non-specialist.

C. P. Whittingham

SELECTIONS FROM PARACELSUS

Paracelsus

Selected Writings. Edited with an Introduction by Jolande Jacobi. Translated by Norbert Guterman. Pp. 347. (London: Routledge and Kegan Paul, Ltd., 1951.) 25*s.* net.

THIS book is a sort of Paracelsian anthology, although not the first by any means, as the literature on Paracelsus is already voluminous. Many attempts have been made to translate and clarify the works of the man who was "one of the most enigmatical figures in history", and surely one of the strangest. According to Dr. J. Jacobi, Paracelsus has a greater message for us than he had for our fathers, although more than four hundred years have elapsed since his death. "Like him, we are living in a time of great transition: we, too, are bridges across an impetuous stream, connecting a sinking shore with a shore that is barely beginning to emerge." Even to-day the ideas of Paracelsus may suggest to modern minds the way to a new reality.

But the task of interpretation is hard. The German of Paracelsus is not easy to translate, his meaning is often confused and ambiguous, and he is anything but a polished writer. Nevertheless, he reflects those values which are, and always will be, indispensable to the Christian civilization.

His basic motif is man, as the beginning and centre of all creation. Few writers before him, and scarcely anyone after him, have conceived an anthropocentric system so lofty and at the same time so rational. It is a question, however, whether the present selections from the works of Paracelsus do not err on the side of over-simplification. The author confesses to having omitted "specifically medical material", "the paraphernalia of superstition", and "all polemical and eccentric texts"; accordingly, the Paracelsian scholar may well wonder what is left. Nevertheless, as an introduction to a deeper study, the book will serve as a useful guide to that mass of confused learning which Paracelsus produced, and which is still so baffling to scholars.

The story of his wandering life and of his constant struggle for recognition is told in the introductory chapter. Then follow many selections from the works of "this strange Renaissance personality, so amply endowed with genius"—to quote from the foreword of Prof. Jung.

Of course, Paracelsus retained much of the medieval outlook: his idea that the human body consisted of mercury, sulphur and salt shows how he clung to the humoral conception, a view which, in various forms, persisted until almost the eighteenth century. As for his philosophy, it is a quaint combination of ancient and modern thought. The reader must choose for himself those passages which are for him the most suggestive and stimulating. Of course, he will not agree with all the views expressed; but at least they may evoke constructive thinking—a great achievement for any writer.

Each of the passages may be traced to its source with the aid of a key at the end of the book. There are also a glossary to expound the obscure terms, and a bibliography of Paracelsian literature. The woodcuts, not all very clearly reproduced, are 148 in number: the source of each is listed, and they serve to re-create the medieval atmosphere. Unfortunately, the book lacks an index. Nevertheless, it is a reliable introduction to Paracelsus. Each reader must decide for himself whether to join the diminishing ranks of those who view Paracelsus as the 'prince of charlatans', or the rising tide of those who acclaim him as the 'king of physicians and philosophers': there is no middle course.

Douglas Guthrie

DESIGN AND THEORY OF OXIDE-COATED CATHODES

The Oxide-Coated Cathode

By Dr. G. Herrmann and Dr. S. Wagener. Translated by Dr. S. Wagener. Vol. 1: Manufacture. Pp. viii+148; 21*s.* net. Vol. 2: Physics, including Thermal Emission from Metals and Semi-Conductors. Pp. xiv+311; 42*s.* net. (London: Chapman and Hall, Ltd., 1951.)

THIS translation of Drs. G. Herrmann and S. Wagener's well-known "Die Oxydkathode" is the first comprehensive work on the subject to appear in English since 1934, when Riemann's classic "Thermionic Emission" was published. It is all the more welcome because the earlier book was based on a physical model which is now outmoded—namely, the view that the high specific emission from oxide cathodes is due to a surface monolayer of metallic barium. During the period 1934–39, experimental work, guided by the theoretical concepts of semi-conductor behaviour proposed by A. H. Wilson, led most investigators to the view that the oxide layer behaves as an excess semi-conductor and that surface effects play only a subordinate part in the emission. During the Second World War, although great experimental progress was made, particularly in the field of pulsed emission, theoretical work was neglected. Since the War many physicists have become interested in semi-conductors, and many studies have been devoted both to the technical and to the laboratory behaviour of oxide cathodes. The situation to-day is, broadly, that there are two schools of thought: that which affirms the general truth of the semi-conductor theory; and a second which believes the cathode to behave as a semi-conductor at temperatures well below the operating range, but considers that conduction through an electron gas in the pores of the crystalline mass is a dominant feature in the operating range. The clearest experimental evidence for the first school is in work carried out by Hannay, Macnair and White, while the researches of Loosjes and Vink provide support for the second view. Various compromises between the schools have also been suggested.

The original edition of Herrmann and Wagener's book appeared in 1944 and propounded the semiconductor theory, while emphasizing that surface effects and differences between the behaviour of single crystals and aggregates might introduce quite considerable modifications. In translation, the literature up to the beginning of 1950 has been surveyed, so that the reader is informed of the most important developments; but the authors wisely attempt no final decision between the theories. This must await further experiments.

Vol. 1 collects most of the information vital to an understanding of the technical preparation and manufacture of oxide cathodes. Vol. 2 is devoted to the theory. It summarizes the statistical theory of emission from metals, gives the basis of the theory of ionic solids and compares the observed behaviour of cathodes with the theoretical expectation. Allied phenomena, such as secondary emission and photoemission, which give valuable information on the behaviour of oxides, are dismissed very curtly. The advent of an unbiased and authoritative survey of the field is most timely, and the book should be widely read.

RESEARCHES IN APPLIED MECHANICS

Advances in Applied Mechanics

Edited by Richard von Mises and Theodore von Kármán. Vol. 2. Pp. x+233. (New York: Academic Press, Inc., 1951.) 6.50 dollars.

THIS is the second volume of the series edited by R. von Mises and T. von Kármán, and entitled "Advances in Fluid Mechanics". The present volume contains five contributions, which deal respectively with the statistical theory of isotropic turbulence, by von Kármán; the laminar boundary-layer in compressible flow, by Kuerti; bending of curved tubes, by Clark and Reissner; recent developments in inverse and semi-inverse methods in the mechanics of continua, by Nemenyi; and the theory of filtration of liquids in porous media, by Polubarinova-Kochina.

The first contribution, which occupies only nineteen pages, is nevertheless one of the most important, as it gives a critical survey of recent developments of the theory of turbulence, including the work of Heisenberg and Kolmogoroff and Batchelor.

The survey of boundary-layer theory given by Kuerti provides a most valuable account of the work which has been done in this field in the United States, Great Britain and Germany. It is an invaluable survey for the research worker in this field.

The article on the bending of curved tubes deals with an elastic problem of considerable practical importance; but it is very surprising to find no reference whatever to the pioneer investigation of Brasier, who was the first to point out the flattening of a circular tube during the process of bending.

The use of inverse and semi-inverse methods in the mechanics of continua has led to results of considerable importance in the theory of fluid motion, including the effects of compressibility and viscosity, and also in the theory of elasticity and plasticity. It was, of course, in St. Venant's original researches on the theory of elastic rods that the theory of inverse methods was first introduced. In this article, Nemenyi gives an account of recent developments, and provides a most useful summary of the important results which have been obtained in various branches of mathematical physics.

Lastly, we have a long and important article on the theory of filtration, which is especially valuable as it makes available for English-speaking readers a considerable volume of research which has been conducted in the U.S.S.R. on this subject. Most of the research is concerned with finding exact solutions of the basic equations of filtration.

There is no doubt whatever that this series of volumes is of very great value for all who are interested in recent developments of applied mechanics, and it is very much to be hoped that succeeding volumes will appear at shorter intervals.

VITAMIN METHODS

Vitamin Methods

Edited by Dr. Paul György. Vol. 2. Pp. xi+740. (New York: Academic Press, Inc., 1951.) 14.50 dollars.

THIS second volume of Dr. Paul György's "Vitamin Methods" keeps well up to the high standard and reputation set by Vol. 1 (see *Nature*, 166, 364; 1950). The first volume was devoted to an account of the physical, chemical, microchemical and microbiological techniques commonly used in determining the vitamins, so Vol. 2 deals with those alternative procedures that are based on biological methods of assay. Sections are also included on the clinical and laboratory appraisal of human vitamin deficiencies, as well as on the statistical methods used in vitamin research. Nor is that all: so unremitting has been the progress of knowledge that Dr. György has found it necessary to add a supplement, covering the more recent literature, and thereby bring up to date the account of the physical, chemical and microbiological methods previously given in Vol. 1. Specially valuable is the attention here given to the microbiological determination of vitamin B_{12}.

The team of authors is the same as in Vol. 1. A preliminary chapter on "General Aspects of Small Animal Experimentation" is by N. B. Guerrant. The main section of the book, on "Animal Vitamin Assays", is jointly by C. I. Bliss and Dr. György, and deals in turn with vitamins A, D, E, K, B_1, riboflavin, nicotinamide, pyridoxin, pantothenic acid, biotin, folic acid, vitamin B_{12}, and vitamin C. "The Laboratory Diagnosis of Human Vitamin Deficiencies" is in the hands of J. H. Jones; and the chapter on "Clinical Signs of Malnutrition" is by N. Joliffe. C. I. Bliss contributes the general section on "Statistical Methods in Vitamin Research".

Throughout the book the accounts of the principal methods described are sufficiently full and explicit to be used as working directions. Also, the underlying theory, and often the historical background as well, are adequately sketched in. The statistical basis, and the method of calculating and of presenting the result, are always clearly set out; and the value of the book is further enhanced by a remarkably full and internationally representative bibliography.

It is not enough to claim that this book is the best of its kind available—it is, in fact, the only book of its kind available. LESLIE J. HARRIS

Advances in Enzymology and related Subjects of Biochemistry

Edited by F. F. Nord. Vol. 11. Pp. viii+471. (New York and London: Interscience Publishers, Inc., 1951.) 9 dollars.

THIS volume exhibits the same characteristics as previous volumes of this well-known series. Like its predecessors, it interprets the field of enzymology very widely, and the range of topics in this volume is so diverse that all that can be usefully done in most cases is to indicate the subjects. Dr. H. Gutfreund discusses the concept of entropy and gives a few applications in the biological field. This article will no doubt be useful to those biologists who are not familiar with thermodynamics. Prof. J. F. Danielli and J. T. Davies discuss reactions at interfaces. Much of this article is concerned with the adsorption of simple substances; but there is also an interesting account of some surface reactions.

The rest of the volume is more specifically biochemical. Dr. E. C. Wassink discusses chlorophyll fluorescence and its bearing on photosynthesis; E. S. Guzman Barron has an article on thiol groups of biological importance, in which he assembles a large quantity of information on the occurrence and mode of action of these groups. This is followed by three articles dealing with enzymic transformations of polysaccharides, in which both synthetic and degradative reactions are discussed. The last two articles, on alliin, the specific principle of garlic and on pathological wilting in plants, seem a little remote from enzymology, but no doubt will be of great value in the field of plant biochemistry, which is not well catered for elsewhere. The present volume contains a cumulative index to Vols. 1–11, which shows how widely the editor of these volumes has cast his net, in all fields of applied biology.

Electrophysiological Technique

By C. J. Dickinson. Pp. vii+141. (London: Electronic Engineering, 1950.) 12*s*. 6*d*.

A POWERFUL research tool has been developed in the application of electronic techniques to neurophysiology, and the chief aim of this book is to give a concise account of the way in which such techniques may be used. After describing the essential features of power supplies, cathode-ray tubes, time bases and the type of amplifier required for biological research (including D.C. amplifiers), Mr. C. J. Dickinson devotes his later chapters to a description of modern techniques for time marking, stimulating, light and temperature measurement, production and recording of mechanical movement, and other related subjects. The book is intended to be a manual of essentially practical information for use by physiologists in the laboratory, and as such it may be recommended. J. A. S.

Clean Milk

By Harry Hill. Pp. vii+115. (London: H. K. Lewis and Co., Ltd., 1952.) 7*s*. 6*d*. net.

THIS useful practical handbook on the production of clean milk describes the sources of contamination of raw milk, hygienic methods of milking, straining and cooling of milk, cleansing and sterilization of utensils and milking machines, with a rough outline of relevant laboratory tests. Mere recital of all possible causes of contamination inevitably creates an impression that the production of clean milk is difficult and costly. The author stresses the importance of appreciation of principles and their correct application, rather than possession of elaborate buildings and equipment, and rightly places major emphasis upon cleansing and sterilization of utensils. Producers of unsatisfactory milk, whose failure arises from lack of knowledge, and educational workers who advise them, will find in this book the practical information they need, clearly presented for ready reference.

Whether milk producers should be encouraged to add sodium chromate to refrigerator brine, to use hypochlorites for sterilizing milk bottles, or to rely upon residual fat films to protect utensil surfaces from hypochlorite corrosion is rather debatable. More emphasis might have been placed upon the distinctive functions of detergents and hypochlorites, and the bald statement (p. 96) that "caustic soda is not a detergent" requires modification. The book will not appeal to dairy scientists; bacteriological matters, in particular, include some loose statements and doubtful descriptions which fortunately do not detract from the value of practical instructions. The chapter on laboratory tests, which includes no mention of standards, is perhaps the least satisfactory. Future editions would be improved by a few illustrations, and a fuller treatment of milk-borne pathogens. E. L. Crossley

Theory and Design of Valve Oscillators for Radio and other Frequencies

By Dr. H. A. Thomas. (Monographs on Electrical Engineering, Vol. 7.) Second edition, revised and enlarged. Pp. xv+317. (London: Chapman and Hall, Ltd., 1951.) 36*s*. net.

Basic Electron Tubes

By Donovan V. Geppert. (McGraw-Hill Electrical and Electronic Engineering Series.) Pp. viii+332. (London: McGraw-Hill Publishing Co., Ltd., 1951.) 42*s*. 6*d*.

THE second edition of Dr. H. A. Thomas's "Theory and Design of Valve Oscillators" has been enlarged by the addition of three chapters on various types of ultra-high-frequency oscillator and by including a more complete study of resistance-capacity oscillators. Square-wave and saw-tooth oscillators are not included because the existing literature makes it unnecessary. The main feature of the book is its careful treatment of frequency stability and stabilization. Amplitude stability is not extensively treated, and it is rather surprising to find no reference to the Meachum type of bridge-stabilized oscillator which is so widely used in telecommunications. Neither is Dr. Thomas well at home in the ultra-high-frequency field. The general theory of non-linear systems is applied to valve oscillators, and this is a valuable corrective to the over-simplifications common in elementary text-books.

Mr. D. V. Geppert says he has aimed at making his book "readable to the average undergraduate and yet advanced enough to give . . . a really satisfying treatment of the physics and mathematics of electron tubes". Two-thirds of the book deal with vacuum devices, the rest with gas tubes. The best feature is the illustrations of potential models, electron paths, etc., in multi-electrode valves. The worst is a tendency to indulge in sweeping half-truths. The book is very elementary—for example, it contains a description of the influence of triode geometry on μ—but not even the simplest formula is derived. One may justifiably doubt the satisfactory nature of a treatment at this level.

THE BRITISH ASSOCIATION

BELFAST MEETING, 1952

By Dr. ERIC ASHBY

President and Vice-Chancellor, Queen's University of Belfast

THIS year the British Association will meet in Belfast during September 3–10. On three previous occasions Belfast has acted as host to the Association: in 1852, 1874 and 1902. Newspaper comments on these meetings reflect vividly the changed relations between scientists and the public in Britain. The 1852 meeting was scarcely noticed in the local press. The *Belfast News-Letter* reported one paper only—an account of the sanitary statistics of Belfast. There was at the time an outbreak of cholera in Berlin and Warsaw, and the editor's comment was "Let there be a board of health in every house and a humble reliance on the mercy of Him who holds the rod of chastisement, and the plague will pass us by". There was plenty of evidence in the Belfast of 1852 of that public indifference to science which the Association was working to overcome. Twenty-two years later no one could have accused the Belfast public of indifference. John Tyndall had given a presidential address which was interpreted as materialistic. On the following Sunday every pulpit thundered against the Association and its despicable scientists. It was left to T. H. Huxley to heal the breach through his lecture on "The Hypothesis that Animals are Automata". A serious strike of local millworkers was ended through the mediation of the Association, a success which enhanced the prestige of economists, who felt (and at that time rightly felt) they were the poor relations of the Association. The newspapers, though still critical and patronizing, were certainly not indifferent to the meeting. The scientists had stirred the public: some two thousand people attended the meetings. By 1902 the Association's meetings were receiving the serious attention of the press and the respectful interest of the public which we nowadays take for granted. James Dewar was president. The sections met (as they will this year) at Queen's University, and Methodist College and in surrounding halls. Sunday produced an innocuous crop of sermons: the bitter feeling between religion and science, which Newman half a century earlier had shown to be unnecessary, had now vanished except from the minds of a few bigoted reactionaries.

In 1952 the Association is assured of an enthusiastic welcome. The City, the University, and the Northern Ireland Government are making adequate preparations for Ulster to become for one week the focus of British science. Meetings will be held at Queen's University, Methodist College, Stranmillis College, and in the City Museum. Belfast is a splendid centre for excursions, and (apart from sectional excursions) members will have to choose among trips to the Mourne Mountains, the Antrim coast, Donegal, and Dublin. There will be opportunities to see the agriculture of Northern Ireland, the linen industry, shipbuilding and other industries.

For his presidential address, Prof. A. V. Hill has boldly chosen "The Ethical Dilemma of Science". Evening discourses are to be given by Mr. A. C. Hartley (on engineering), Prof. A. Macbeath (on philosophy), and Sir William Slater (on science in agriculture). The sectional presidential addresses include topics as varied as the assessment of personality (Section J), Britain's food supplies (Section M), and progress in aeronautical science (Section G).

Belfast has the honour of having initiated the handbook on the geography, natural history, and economics of the region, which is now a regular feature of Association meetings. The first handbook was produced in 1874 by the Belfast Naturalists' Field Club. The handbook for 1952 is the work of some dozen authors under the direction of Prof. Estyn Evans. Armed with this book, and with the help of exhibitions illustrating the archæology of Ulster, and with the co-operation of the Naturalists' Field Club (which is holding a conversazione during the meetings) the visiting naturalist, historian or archæologist will have good opportunities to see during the week what Northern Ireland has to offer him.

A special feature of the Belfast meeting will be its provision for young people. There will be five afternoon lectures for boys and girls: "Seeing is Believing", by R. J. Bartlett; "Noises, Old and New", by Prof. G. H. Bell; "The Honey Bee", by C. R. Ribbands; "Animals of the Past", by W. E. Swinton; and "Travel and Adventure on the Roof of the World", by F. Kingdon-Ward; and in addition a series of biological films. Tickets for these lectures are available only for student members of the Association—not for full members; but they must be secured before June 4. After this date the remaining tickets will be distributed among senior schoolchildren in Northern Ireland. Another special feature for students is a tour of Ireland to be held immediately after the meeting, under the guidance of students from Queen's University.

There will be the usual social events which accompany Association meetings, with one notable addition: Northern Ireland has its own Government, and the Government is to entertain the Association at Stormont. Members will welcome this event not only for its own sake, but also to give them an opportunity of seeing something of the benefits of devolution of government, an experiment in which Northern Ireland has unique experience.

In these days of specialist scientific societies, and with the calendar peppered with technical conferences and seminars, the British Association is no longer the place for the announcement of major new discoveries in science. In recent years the Association has been restored to its original purpose: to be a place where scientists in different fields interpret their work to one another and to the public. It might be argued that this original purpose has now been fulfilled. The public spends some £16 million a year on civilian scientific research, quite apart from £20 million a year spent on universities: surely it is no longer necessary to arouse public interest in science; and in any event have we not the Third Programme, and a flourishing popular scientific literature, to maintain interest? This is a topic which might well be discussed by the British Association itself; but there is not much doubt what the outcome would be. For scientists are now dependent on

public support in a way they never were before. A century ago private subscriptions could at a pinch have supported the whole body of scientific research in Britain. To-day the man-in-the-street is the patron of science. Without his support our universities and research institutions could not pay even their salary cheques for the next quarter. Therefore the interpretation of science to the public has now become a major activity in modern society, not to be entrusted entirely to the efforts of scientific journalists; and the British Association remains the chief instrument for this activity.

HERBICIDES AND SYSTEMIC FUNGICIDES

THE field of herbicides and systemic fungicides is one in which planned progress depends on the collaboration of chemists and biologists. Such collaboration was exemplified by a joint meeting, held at the Imperial College, London, on March 14, of the Association of Applied Biologists and the Crop Protection Panel of the Society of Chemical Industry.

Herbicides

The morning symposium on herbicides was presided over by Mr. W. E. K. Piercy, chairman of the Crop Protection Panel. In the first paper, Dr. E. W. Simon, of King's College, London, described the assessment of the relative toxicities of phenol, *o*- and *p*-nitrophenol and 2 : 4-dinitrophenol by five methods, including tests on fungi and higher plants. The relative toxicities of these compounds were found to be largely independent of the test organism, provided that the comparisons were made at *p*H-levels at which there was little dissociation. At these levels the descending order of toxicities was: dinitrophenol, mono-nitrophenols, phenol. Lower concentrations were required in tests based on growth responses (*Trichoderma* and *Lemna* tests) than in tests in which respiration-rates of yeast and of infiltrated leaf disks of *Brassica alba* were measured. This finding supported the hypothesis that nitrophenols owed their toxicity to the uncoupling of oxidative phosphorylation. Relatively high concentrations were required to kill *B. alba* seedlings in spraying tests, a reflexion presumably of the high concentration gradient needed to ensure that sufficient of the compound passed through the cuticle and plant tissues to build up a toxic dose within the individual cells.

Mr. G. W. Ivens, of the Agricultural Research Council Unit of Experimental Agronomy, Oxford, speaking on the phytotoxicity of mineral oils and hydrocarbons, made the point that, while the practical use of mineral oils as herbicides had demonstrated that phytotoxicity was roughly dependent upon boiling range and aromatic content, more precise correlations between toxicity and physico-chemical properties were needed before herbicidal potentialities of particular oil fractions could be predicted. Spraying results with individual hydrocarbons indicated that the order of increasing phytotoxicity was: paraffins, olefins, naphthenes, aromatics—the phytotoxicity increasing with boiling point. In such experiments, however, it was difficult to judge how the toxicity estimates were affected by differences in the penetration of liquids into the intercellular spaces of the leaves.

Such differences were eliminated by exposing detached runner-bean leaves to hydrocarbon vapours. The toxicities of representatives of all four major groups of hydrocarbons estimated in this way showed a close inverse relationship with vapour pressure, and there was little difference in toxicity between the groups. As toxicity increased, the ratios between vapour pressure of equitoxic concentrations and saturated vapour pressure (thermodynamic activity) rose, reaching 1·0 with compounds boiling at about 170° C. Compounds of higher boiling-point were non-toxic as vapours. Leaves of a plant resistant to oil spray (parsnip) showed similar relationships; but higher concentrations were needed to cause injury and the 'activity' reached 1·0 at about 140° C. The 'activities' of all compounds tested were between 0·3 and 1·0, suggesting that hydrocarbons act on plants as 'structurally non-specific' substances.

Phytotoxic effects of 'hormone' herbicides on cereal crops were described by Mr. E. B. Scragg, of the North of Scotland College of Agriculture, Aberdeen. If such herbicides were applied while the spikelet primordia were being differentiated, they induced various types of abnormalities in the ears, caused by multiplication or fusion of parts. Application of 'hormone' herbicides after the completion of differentiation of the ear could cause sterility of the florets. In all cereals, the stage of maximum susceptibility was immediately before tillering.

All the species and varieties of cereals tested were susceptible to damage. Of the herbicides in commercial use, the amine salt of 2 : 4-D (2 : 4-dichlorophenoxyacetic acid) caused most damage and the sodium salt of 2 : 4-D least. Methoxone (sodium salt of 2-methyl-4-chlorophenoxyacetic acid) and the *n*-butyl ester of 2 : 4-D were intermediate in phytotoxicity.

The direct effect of 'hormone' herbicides upon yield was also influenced by time of application. Very early applications had in some experiments given considerable reductions in yield. In other experiments, there had been no reduction, despite the presence of a high proportion of abnormal ears. Late applications, by causing infertility of the florets, decreased yield.

Increase in grain size and in crude protein content had sometimes been found in sprayed crops. Viability of the grain did not appear to be impaired.

Systemic Fungicides

The chairman for the afternoon session, on systemic fungicides, was Mr. R. W. Marsh, president of the Association of Applied Biologists. The symposium was introduced by Prof. R. L. Wain, of Wye College, who directed attention to the modern successes in animal chemotherapy which had led to a renewed interest in the possibility of controlling plant diseases by introducing curative chemicals into the plant. This technique had been employed in the United States by Horsfall and Howard, who had obtained encouraging results, using various unrelated chemicals against systemic diseases such as the various wilts, for which other methods of control were not available.

In Britain, Crowdy and Wain, studying compounds which might be translocated in plants, found systemic fungicidal activity in certain aryloxyalkylcarboxylic acids. Brian *et al.* demonstrated the marked systemic fungicidal properties of griseofulvin, an antibiotic which might be present in soil.

Many factors could influence the ability of a compound to show activity as a systemic fungicide. Thus, it might not be taken up by or transported within the plant; it might be modified chemically under the influence of plant enzymes or it might be phytotoxic. However, the biological result in any test represented the net effect of these and other factors, though any protection achieved might be entirely different if other fungi and other host plants were used.

In Nature, most plants were resistant to most pathogens. Such resistance might be related to morphological characteristics though in certain cases natural resistance could well have a chemical basis. These considerations indicated lines of approach to problems of systemic fungicidal action which might give fruitful results.

Mr. S. H. Crowdy, of Long Ashton Research Station, Bristol, distinguished between chemotherapeutants—compounds able to reduce plant disease by acting within the host—and systemic fungicides, which were chemotherapeutants readily distributed within the host and acting against a specific fungus pathogen. Usually, systemic fungicides would not prevent infection but checked the development of disease after infection had taken place. The effect of compounds was assessed on their ability to cause this check and was recorded usually by measuring the extent of disease in a stated period after infection.

Mr. Crowdy described the method of bioassay of systemic fungicides used at Long Ashton, where the chief test disease was chocolate spot of broad bean, damage to both leaves and flowers being assessed. On leaves, disease could be measured either as a visual estimate of total damage or by taking the diameters of individual lesions. The latter estimate was less liable to personal bias and less dependent on uniformity of inoculation; on the other hand, it took no account of the ability of a compound to suppress lesion formation. Flower damage was estimated as the percentage of dead flowers per inflorescence. The results obtained with this test were confused by a marked disease gradient on the host. The top leaves developed fewer lesions, and those which were formed were small. It would be possible to avoid much of this variation by omitting the top of the plant in assessment; but many of the compounds used had differential effects on organs of different age, which gave the youngest leaves a special interest.

Among the materials found successful in reducing chocolate spot in the Long Ashton tests were compounds derived from the following: benzoic acid, phenoxy-acids, naphthoxy-acids and hydroxyquinolines.

Dr. P. W. Brian, of the Butterwick Research Laboratories, Welwyn, referred to the antagonism between saprophytic micro-organisms and soil-borne plant pathogens, which might be based on the production of antibiotics by the saprophytes, many of which produced antibiotics in artificial culture. The rhizosphere would be one of the most likely loci for natural biosynthesis of antibiotics, which might then pass into plants through the roots. Experiments previously described (*Nature*, **167**, 347; 1951) had shown that griseofulvin, an antifungal metabolic product of the common soil mould *Penicillium nigricans*, would enter through the roots and thence be distributed systemically. This conferred on the plant resistance to fungal attack; control of the following diseases had been observed: *Botrytis fabæ* on broad beans, *Botrytis cinerea* on lettuce, *Alternaria solani* on tomato, and *Erysiphe graminis* on oats and barley.

Dr. Brian referred to an approach to treatment of plant disease, which had received attention in the United States, namely, the systemic application of substances which might neutralize or serve as antidote to phytotoxic metabolites liberated by a plant pathogen within the host plant. Consideration of work by Gäumann and his colleagues on toxins produced by *Fusarium lycopersici* and by Brian and his collaborators on toxins produced by *Alternaria solani* suggested strongly that the toxins might vary from strain to strain of any parasitic species. The task of finding an antidote to all the possible toxins involved in any one plant disease made this approach to plant chemotherapy more complex than might be thought at first sight.

Experience at the Hawthorndale Laboratories of Imperial Chemical Industries, Ltd., in developing a standard method for evaluating the systemic activity of griseofulvin and other chemicals was briefly discussed by Dr. J. Stubbs. *Alternaria solani* on tomato was finally selected for this work. For root absorption tests, small tomato plants grown in sand in wax cartons were watered daily for four days with the test chemical. They were then inoculated with spore suspensions and kept at high humidity for 24 hours before being returned to the greenhouse. Disease estimation was made two days later by counting the lesions on one or more leaves of each plant. For leaf absorption tests a promising method was to spray some of the leaves while others were suitably shielded, as by a polythene envelope. This technique had not yet been fully standardized but was being developed alongside the root absorption method.

When applied by the root absorption method, griseofulvin at 0·05 per cent gave almost complete control of the disease. Other systemic fungicides gave results similar to those reported elsewhere. Persistence studies showed that griseofulvin remained fully active for four days, after which there was a fairly rapid loss of activity.

Dr. W. G. Keyworth, of the East Malling Research Station, discussed studies of the tomato *Fusarium*-wilt tests for screening chemotherapeutants which he made at the Connecticut Agricultural Experiment Station during 1951. The test compounds were applied on ten successive days to the roots of tomato plants growing in sand. The plants were then uprooted, their roots washed and dipped in a bud-cell suspension of *F. oxysporum lycopersici* and the plants re-potted. A standardized assessment of wilt and vascular discoloration was made some twenty-one days later, by which time the control plants were usually severely diseased. Several compounds greatly reduced disease severity.

After observations that certain of these compounds caused root injury, tests were made of other modes of root injury prior to inoculation, to determine whether this influenced subsequent wilting. The methods used were: (*a*) dipping the roots in water at 55° C. for thirty seconds; (*b*) periodic pruning of the roots; (*c*) treatment with compounds known to cause root injury. All three treatments greatly reduced subsequent wilting. Several compounds unlikely to be translocated in the plant (for example, hydrogen peroxide) were highly effective in reducing disease.

Further tests showed that the effect was unlikely to be associated with fungal penetration through the injured roots but was probably caused by an induced resistance of the upper parts of the roots or of the lower stems. It was further noted that the metabolism of the injured plants had been greatly altered, inducing an accumulation of soluble carbohydrates in the aerial parts. It appeared likely that the effects of certain compounds lay in their effect on host resistance and not in systemic fungicidal action on the pathogen.

These observations emphasized the fact that the chemical treatment of plants in an attempt to obtain systemic fungicidal action might affect the host. Such effects might not necessarily be as drastic as those noted above but might, even so, play a part in any subsequent reduction in fungal invasion. The work also suggested ways in which host resistance may be further investigated.

In the lively discussion following these contributions, many speakers commented on the effect of external environmental conditions on the expression of systemic fungicidal action. These conditions presumably affected the power of the host to absorb and translocate the active compounds.

In summarizing the discussion, Prof. Wain recommended that the fundamental approach to studies on systemic fungitoxicity should not be overlooked. Such factors as the stability of compounds, their movement within the plant and the effects of systemically-acting compounds on normal plant biochemical processes should be made subjects for research. He awaited examples of control of plant diseases using systemic fungicides under field conditions.

R. W. Marsh

SCIENTIFIC INSTRUMENTS FOR RESEARCH AND INDUSTRY

PHYSICAL SOCIETY'S EXHIBITION, 1952

THE thirty-sixth annual exhibition of scientific instruments, organized by the Physical Society, was formally opened by the president of the Society, Prof. L. F. Bates, on Thursday, April 3. In his opening remarks he pointed out that the Council of the Physical Society regards this exhibition as one of the most important aspects of the work of the Society. Of its national importance there can now be no doubt; after thirty-six years (excluding the war years) of steady progress it has become increasingly popular, and is now regarded as an outstanding event of 'the scientific year'. At the time of writing, the death of Sir Stafford Cripps recalls the first post-war exhibition in 1946. That exhibition was opened by Sir Stafford Cripps, who was then president of the Board of Trade. In his concluding remarks, after paying tribute to the excellence and importance of the scientific instrument industry, he said: "It is essential that we should have and maintain in this country a pre-eminent scientific instrument manufacture both for our own use and to help to supply those many other countries who cannot themselves afford to set up such manufactures". The Council of the Physical Society, in organizing these splendid annual exhibitions, is doing much to encourage the development of a pre-eminent scientific instrument industry. The recent thirty-sixth exhibition upheld the standard set by its predecessors. It was held by kind permission of the College authorities in the large rooms of the Imperial College and of the Huxley Building, South Kensington. The exhibition was open for five days, from Thursday, April 3, to Tuesday, April 8 (excluding Sunday). The total turnstile figures indicated an attendance of more than 17,000 in the Main Building of the Imperial College and more than 9,000 in the Huxley Building. There can be no doubt that the extension of the exhibition to the Huxley Building has resulted in less over-crowding, and it would seem advisable now to consider a less-complicated system of issue of tickets than that hitherto found necessary.

As usual, an important feature of the exhibition were the discourses given by lecturers eminent in special branches of scientific research. On this occasion two special discourses were arranged: (1) "Engineering Supersonic Aerodynamics", by Mr. B. N. Wallis (of Vickers-Armstrong, Ltd.), and (2) "The Physical Basis of Colour Photography", by Mr. E. R. Davies (of Kodak, Ltd.). At short notice, a third discourse was given on "The Torpidity of Liquid Surfaces", by Dr. K. Hickman (of Rochester, New York).

The discourse by Mr. B. N. Wallis on "Engineering Supersonic Aerodynamics" was given on Friday evening, April 4. Mr. Wallis said that since the end of the Second World War and following the rapid development of jet propulsion, the principal interest in aerodynamics has moved from the study of fluid motion at subsonic speeds to that at supersonic speeds. In what might be called its subsonic era the anatomy of the aeroplane could be treated as substantially two-dimensional, and the problems of three-dimensional flow were of relatively minor interest. Supersonic aircraft, on the other hand, must comprise an essentially three-dimensional, as well as a two-dimensional, element in their anatomy. So great may the drag of a three-dimensional body become that three-dimensional supersonic flow is correspondingly important. Moreover, some rearrangement of the wing – body combination is necessary if an overwhelming penalty in interference drag is to be avoided. If complete freedom of anatomical arrangement be assumed, wing – body combinations can be suggested the drag of which might be less than the sum of the drags of the components taken separately. 'All-wing' and 'Delta' aircraft illustrate attempts to attain this benefit. The necessity for low drag, however, focuses attention on flow in the boundary layer. The opinion commonly held that this must be turbulent at the high Reynolds' numbers involved is based on practical rather than theoretical reasons. If the conditions known to be necessary for stable laminar flow are present, there is the possibility that it will be maintained at least over a large part of the surfaces involved. Can any anatomical arrangement be devised for the now essential association of body and wings whereby the two sets of conditions, that is, those for favourable interference drag and those for minimum frictional drag, are satisfied simultaneously?

Mr. E. R. Davies gave his discourse on "The Physical Basis of Colour Photography" on Monday evening, April 7. He pointed out that most colours can be matched visually by some additive mixture of a beam of red light, a beam of green light and a beam of blue light; this has long been known, and was used by Maxwell in 1861 to make the first colour photograph. All modern processes of colour photography depend on the same principle, the subtractive

method of forming colours with various concentrations of cyan, magenta and yellow dyes being merely a convenient way of controlling and mixing the red, green and blue components. Even when applied in its simplest form, however, this principle is incapable of reproducing colours with their correct hues, saturations and lightnesses, and in practicable processes the errors can be considerable. Despite the inherent errors, many modern processes of colour photography produce highly satisfactory results. This is largely because colour is, to the observer, not a physical quantity but a sensation, and many subjective effects are operative both when the original and the reproduction are viewed.

The discourse on "The Torpidity of Liquid Surfaces" was given by Dr. K. Hickman on the evening of April 3. Dr. Hickman, an expert on high-vacuum physics, happened to be in Great Britain during the period of the exhibition and was invited to give this lecture. Experiments with the high-vacuum short-path still suggest that liquids in the common state of purity are covered with a film of contaminating molecules which retard evaporation. The 'accommodation' or evaporation coefficient is thus less than unity. When such liquids are ejected from a nozzle, their surfaces remain clean for the first tenth of a second and the coefficients become unity. When they are evaporated in a pot still, the contaminating layer may divide abruptly into two parts, a torpid and a working area. This effect is most pronounced in the range of vapour pressures 30–300 microns. It is almost exactly analogous to steam pushing aside the skin of a milk pudding in the oven. The working area has an evaporation coefficient of 0·5–0·9, while the torpid area has a coefficient 0·25 to as low as 0·001. At lower temperatures, before the surface has become schizoid, the 'torpidity' is uniformly distributed over the surface, where it is compressed or stretched by every movement of the liquid. Emission of vapour, and composition of vapour from a gross mixture, vary rapidly, increasing with tension and diminishing with compression. This is a universal property of liquids occurring, for example, with the common plasticizers and glycerine at elevated temperatures and with butanol at − 30° C. Not until the surface has been rendered purer than ever before, as by weeks of continuous redistillation, with overflowing of the surface, does the relatively stagnant liquid lose these properties and attain an evaporation coefficient of unity.

A list of the hundred and fifty exhibitors with details of the demonstrations and exhibits is to be found in the "Handbook of Scientific Instruments and Apparatus 1952" published by the Physical Society*. The handbook is a well-printed volume lavishly illustrated by half-tone reproductions, and is essential to all workers concerned with the progress, use and development of scientific instruments. The exhibitors included not only industrial firms but also government research establishments and university laboratories, while the exhibits ranged over the whole field of physical instruments and materials used in their construction.

Even a quick and cursory tour of the exhibition gave the impression that the exhibits this year had attained a very high standard of quality. This impression was confirmed later by a more detailed inspection of some of the exhibits. The following 'miscellaneous' remarks refer to a number of such exhibits selected almost at random.

Remarkably high speeds of rotation can be obtained by the use of a doubly tapered rod, rotating about a short axis. The ideal profile is that of a Gauss curve. Examples shown included a blade-ended rotor for generating fast molecular beams in low-pressure gases and a cup-ended rotor for carrying radioactive sources, used for Doppler-effect experiments with gamma-rays. These rotors are constructed in 75-ton alloy steel. Driven electromagnetically in a rough vacuum by a simple method which was demonstrated at low speed, they will reach speeds of about 10^5 cm./sec. (2,200 m.p.h.) before bursting. Apparatus was shown for measuring the particle size of powdered materials in the sub-sieve range using a light-transmission photo-cell method and a standard comparison cell. The particle size and hence the specific surface can be calculated from Stokes's equation for the rate of settlement. Another form of 'sedimentometer' determined the particle size in a sediment by direct weighing with a torsion balance. In the field of vacuum physics a good display of vacuum pumps and vacuum gauges, with many useful applications, were on view. The efficiency and quality of cathodic sputtering were shown to be greatly improved in a magnetic field. In another sputtering unit the normal process for depositing thin metallic films was employed for etching metallurgical specimens since the sputtering occurs preferentially from the grain boundaries.

The electrostrictive and piezoelectric properties of barium titanate (ceramic) are now receiving considerable attention; it is being used in acoustic 'pick-ups' and resonators. In addition to industrial exhibits of this material, the National Physical Laboratory showed it in use for transmitter–receiver probes at 1, 2·5 and 5 Mc./sec. Important metals and alloys for various purposes were exhibited by a number of firms. Zirconium metal can now be obtained on a commercial scale in the form of sheet, rod, wire and tube—this development is of considerable use in the chemical industry, where corrosion resistance to acids or alkalis is very important. Other metals and alloys exhibited included tantalum, molybdenum and tungsten, various electrical resistance alloys, aluminium-clad iron and magnetic alloys. In the latter connexion, a high vanadium–cobalt–iron alloy is being developed which has a high retentivity and coercivity, while being malleable and capable of being pressed either hot or cold.

In the field of acoustics, a low-power ultrasonic apparatus was demonstrated which was designed specially for educational purposes, operating at two frequencies, 1 or 5 Mc./sec. A wave analyser, designed primarily for the analysis of complex vibration waveforms such as those produced by ship turbines and propeller shafts, was shown to be nevertheless suitable for the harmonic analysis of any type of electrical wave-form within the frequency range of 19 c./sec. to 21 kc./sec. and gives an octave discrimination of better than 70 db. A number of types of supersonic flaw detectors for location of internal discontinuities in solids or liquids were on view. The importance of this form of non-destructive testing was exemplified in the National Physical Laboratory exhibit which provided a 'standard' for flaw detection. This consists of a steel block with accurately drilled holes permitting the assessment of behaviour and calibration of flaw detectors.

* "Handbook of Scientific Instruments and Apparatus 1952." As shown at the 36th Physical Society Exhibition. Pp. xl+244+A.76. (Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7, 1952.) 6*s.*; by post, 7*s.* 3*d.*

An interesting and extremely useful application of electro-thermal processes is the development of flexible flat heating elements embodied in sheets of heat-resisting rubber, the whole being vulcanized. These heaters are designed for temperatures up to 200° C. Heating tapes have also been designed for electrically heating all types of pipes, columns, valves, vessels, tanks and similar containers difficult to heat by other means. These tapes consist of metal fabric bands separated and insulated by glass fabric bands, and are available for loadings up to 2 watts/cm.^{2} and temperatures up to 550° C. Very simple and convenient types of bimetallic thermometers were on view. These are made in all sizes from the larger industrial type to very small pocket thermometers. A very small dial-indication clinical thermometer with stainless steel stem has obvious advantages over the old mercury in glass type—which requires shaking to reset and a magnifying glass to read. The dial is reset after taking a reading by simply pressing a knob.

In the realm of optics a good display of the latest types of optical glass was shown. Blocks of boro-silicate crown optical glass, dense barium crown (cast from a platinum 'pot'), and phosphate-base ultra-violet filter glass were on view. In addition to these, glasses prepared from melts of most unusual chemical compositions were shown; for example, glasses of complex tellurites containing at least one of the oxides of lead, barium, lithium or sodium and usually also containing one or more oxides of zinc, magnesium, boron, phosphorus, germanium, vanadium, columbium, titanium, molybdenum, tungsten, tantalum and thorium. Curves showing their excellent transparency to infra-red radiation of wave-lengths at least up to 6 microns were presented. A useful addition to a conventional microscope is provided by a simple unit-magnification concave mirror attachment, which enables the instrument to be used at a much greater working distance than that normally possible. In other exhibits a good display of spherical mirrors, lenses, prisms, windows, proof planes, angle gauges, spectrometers and spectrophotometers was shown. The Physical Society Colour Group staged a series of splendid demonstrations illustrating many of the colour effects obtained by dispersion, diffraction, interference and polarization. Examples were shown of the formation of colours by diffraction gratings having different rulings, of the colours due to difference in refractive index, of interference colours associated with thin films, and of the Lippmann method of colour photography employing stationary waves. Other exhibits of the Colour Group showed how the colours of a butterfly's wing appear to vary according to the position from which it is viewed.

A simple, but effective, device was a magnetic stirrer in which a rotating magnetic field induces a vigorous rotary motion in a small magnetized bar (totally enclosed in a glass or polythene tube) placed in the liquid to be stirred. This device is particularly useful in closed systems where gas volume changes have to be observed. Various demonstrations were shown of the optical properties of 9 mm. electromagnetic waves—dielectric and metal tube lenses, phase-contrast resolution, and the transmission of radiation power by the use of directional transmitting and receiving aerials. In one demonstration of millimetre waves the analogue of the Fabry and Perot interferometer was shown—this required the production of reflectors which had adequate reflectivity without seriously absorbing the millimetre waves, by using dielectric sheets a quarter wave-length thick, spaced a quarter of a wave-length apart in air. In an electronic digital computing apparatus a demonstration was given of the use of a magneto-striction device as a delay line in place of the more conventional mercury tube. This device has the advantages of greater simplicity and ruggedness, requires less space, small insertion loss and the output is easily available at any point along the delay line and may be obtained without interference with the acoustic pulse on the magnetostriction line. As Prof. Bates remarked in his opening address, it was pleasing to note that instruments for enabling the blind to do scientific work are now being made. One of these instruments is the blind man's 'AvoMeter', fitted with a Braille scale and various essential audio-click devices.

An interesting exhibit demonstrated the phenomenon of electrophotoluminescence. The cells or 'luminous capacitors' used in the demonstration are made up of two plates separated by a dielectric layer containing the active material, which is usually of zinc oxide or sulphide composition. One of the plates is a sheet of glass with an inner transparent conducting layer, whereas the other plate is usually a conducting layer of aluminium applied as a backing to the dielectric. The active material is caused to glow by the application of a suitable alternating voltage between the plates. Good displays of charged-particle accelerator equipment, electron microscopes and mass spectrometers were on view. These instruments have now reached an advanced stage of development for industrial use and for research purposes. A model demonstrating the separation of gas mixtures by thermal diffusion was shown. The gas mixture, in this case bromine and helium, is contained in the annular gap between two glass tubes. The inner tube is heated and a temperature gradient is set up across the annular gap. Thermal diffusion is used at Harwell to produce the rare isotopes oxygen-18 and helium-3 from the naturally occurring isotopic mixtures and for separation of gases for analytical purposes. Another exhibit showed a very beautiful series of radiographs illustrating the application of pile-produced radioactive sources in industrial radiography. The Admiralty Naval Construction Research Establishment showed a miniature reflecting polariscope used in conjunction with complicated celluloid structural models of ships to indicate the directions of principal stress—this method obviates much of the tedious analysis associated with the use of large numbers of strain gauges.

The exhibition of work by apprentices and learners employed in the design and construction of scientific instruments again reached a very high standard. This competition in craftsmanship and draughtsmanship is a regular feature of the exhibition introduced with the object of encouraging skill and interest in the younger generation engaged in scientific instrument work. The beautiful work in glass-blowing, mechanical and electrical instruments, and drawing was a pleasure to see.

At the exhibitors' meeting held during the exhibition various matters, for example, allocation of tickets, days and hours of opening, and stand-fitting, were discussed with the view of the improvement of future exhibitions.

In conclusion, it is sufficient to state that the thirty-sixth exhibition was well up to standard. The Council and Exhibition Committee of the Physical Society deserve congratulation on the success of their annual effort.

A. B. Wood

OBITUARIES

Mr. Henry Woods, F.R.S.

HENRY WOODS, who died on April 4 at Meldreth, near Cambridge, was the last survivor of the quartet (which included McKenny Hughes, Marr and Harker) who did much to enhance the reputation of the Cambridge school of geology more than half a century ago. Born in 1868, he began his academic career as a scholar of St. John's, and, after taking his degree in the Natural Sciences Tripos, was awarded the Harkness Scholarship in 1890. His first engagement was in curatorial duties in the Woodwardian Museum, and in connexion with this side of his work he produced two catalogues of fossils for the use of research workers and students in the Museum; and in 1893 the first edition of his now famous little book on palæontology was published as one of the Cambridge Natural Science Manuals. Meanwhile, he was appointed in 1892 as demonstrator in palæontology, a post which developed in 1900 into the University lectureship in palæozoology; and he held this office until his retirement in 1934.

Although his first paper, published by the Geological Society in 1894, was concerned with the igneous rocks of the neighbourhood of Builth, Woods's work in the Museum, combined with his patient industry and meticulous care, had led him in the direction of systematic palæontology, to which he was thereafter to devote himself. His first contribution to this subject, an account of the Mollusca of the Chalk Rock, directed attention to the presence in Great Britain of the *Reussianum* fauna. In order to become familiar with comparable material from European localities, Woods visited museums in Bohemia, Belgium, France and Germany. His attention was now directed more particularly to Cretaceous fossils, and he undertook to prepare a monograph of the Cretaceous Lamellibranchia of England, a group that was in special need of nomenclatural revision. This work, published in annual parts by the Palæontographical Society, occupied him from 1899 until 1913. Two sections, the Inocerami and the Ostreidæ, were by no means easy to deal with because of extensive variation and paucity of ornamentation, and the lack of precise details as to horizon and locality of historic specimens. In the case of the Inocerami, he was able to bring order out of confusion by recognizing phylogenetic series, and to correlate progressive modifications of the shell with geological horizons, with results that have proved of great use in stratigraphy. By a broad conception of species in the Ostreidæ he reduced this group to workable order, and thus left the field open to any who might wish to engage in nomenclatural refinements.

While the monograph of the Cretaceous Lamellibranchia was in progress, former pupils and friends were sending him fresh material for determination and description, and as a result he produced well-illustrated memoirs on Cretaceous fossils from South Africa, Northern Nigeria and New Zealand and an account of some Tertiary fossils from Peru. In 1925 he began a monograph of the Fossil Macrurous Crustacea of England which was completed in seven annual parts and published by the Palæontographical Society.

Woods was elected to the Royal Society in 1916. He was awarded the Lyell Medal and the Wollaston Medal by the Geological Society, and was an honorary member of the Yorkshire Philosophical Society and of the Royal Society of New Zealand. Of a retiring disposition, he appeared to be diffident or even shy in his manner; but this was a modesty so natural that it tended to obscure decision and shrewdness. His work has been truly described as faithfully pursued for no private end; and he himself found lasting satisfaction in the knowledge that many whom he met as pupils remained as friends. To this may be added that many outside his circle of pupils had reason to regard him as a friend.

C. P. CHATWIN

Dr. E. H. Farmer, F.R.S.

ERNEST HAROLD FARMER died on April 13 at the age of sixty-two. He was born in Derbyshire, and graduated from University College, Nottingham, in 1911. After three years as a schoolmaster, he served in the First World War in the Loyal North Lancashires. A serious injury in 1917 incapacitated him for the next two years and left his right hand and arm permanently damaged—a disability against which he struggled so successfully that few realized its extent. Demobilized in 1919, he entered the Imperial College of Science and Technology, London, as a research student, and so commenced an association with the College which was to last for twenty years. He obtained the degree of D.Sc. in 1924, and in the same year was appointed to the teaching staff. He was elected a Fellow of the Royal Society in 1948.

Farmer's scientific work and interests were mainly concerned with olefin chemistry. His early work at the Imperial College, carried out in association with Thorpe and Ingold, was an investigation of the structural requirements for the formation and stability of certain *cyclo*propane derivatives. Associated problems, of synthesis and interpretation, led to a study of Michael-type reactions with conjugated compounds, and then to an extensive examination of the effects of reactant structure, solvent and temperature on addition reactions of conjugated dienes and trienes. The results showed clearly the inadequacy of Thiele's theory of reactivity in conjugated systems, and in particular that 1 : 2 addition is an independent process of no less general importance than 1 : 4 addition, although secondary factors often give the latter special prominence. The numerous and not obviously consistent observations could not be satisfactorily correlated at the time; but more recent theoretical developments now permit their significance to be appreciated. It was but a short further step to Diels–Alder and diene–diene reactions, and thus to an interest in hydrocarbon polymerization and high-molecular weight olefins generally. Several publications in the middle 1930's were concerned with the isolation and characterization of some less common natural esters of the paint drying-oil type.

Farmer's connexion with rubber chemistry dates from 1932, when he undertook to supervise some work on modified rubbers for the Rubber Growers' Association. In 1938 he resigned his academic appointment to accept the post of senior organic chemist in the newly-formed British Rubber Producers' Research Association, and the succeeding years yielded his most influential work. In the main this originated from his recognition that the key to the nature of autoxidative changes in non-conjugated olefins, including industrially important materials such as rubbers, drying oils, edible oils and fats, and petroleum products, lay in Criegee's demonstration that *cyclo*hexene and oxygen combined to give

*cyclo*hex-2-enyl hydroperoxide as the primary product. Farmer's subsequent work showing the widespread importance of α-methylenic reactivity, and his discussions of its mechanistic features greatly stimulated activity in this field, notably in the United States, and also served to advance the opinion that the chemistry of complex substances is often resolved most expeditiously by initial studies of model systems. His final researches were concerned with the reactions between sulphur (in various forms) and olefins, and have provided a new experimental background from which to approach the intricacies of rubber vulcanization.

Farmer leaves a widow, Marjorie (*née* Wilson-Smith), whom he married in 1930; she has assisted him in some of his researches.

GEOFFREY GEE

Prof. Kurt H. Meyer

KURT HANS MEYER, whose death at the age of sixty-eight occurred on April 14, was the son of the late Hans Horst Meyer, the veteran Viennese physiologist and pharmacologist. Kurt Meyer was a chemist of quite unusual breadth of interests within his science. From early youth he was strongly attracted to the field of biology, and indeed he began his academic career as a medical student. This orientation was scarcely surprising, since his father was that very Meyer whose name, linked with that of Overton, is known to all biologists in the Meyer–Overton theory of the role of lipoids in cell permeability. For K. H. Meyer, however, the appeal of organic chemistry proved too strong to be ignored. A pupil of Zincke and Hantzsch, he made his name in Baeyer's laboratory with work on the keto-enol equilibrium of aceto-acetic ester; and in 1918, at Willstätter's invitation, he took over the organic department at the Chemisches Institut in Munich, where he continued his study of aceto-acetic ester and accomplished the separation of keto and enol forms by a simple distillation.

Meyer's growing interest in dyes and dyeing soon led to his appointment as director of the Hauptlaboratorium der I. G. Farbenindustrie at Ludwigshafen. From that laboratory, he and H. Mark published in 1930 their historic treatise, "Der Aufbau der hochpolymeren organischen Naturstoffe (auf Grund molekular-morphologischer Betrachtungen)", the outcome of joint researches begun in 1927. In this early study they put forward, as part of a general scheme, molecular models developed by them for cellulose, cellulose derivatives and related substances, such as hemicelluloses and chitin; for rubber, gutta percha and balata; for proteins (in particular for silk fibroin); and they discussed the importance of the chain-molecule concept in plant and animal morphology, its relation to macroscopic and molecular changes in shape, and to muscular contraction and protoplasmic movement in particular. At the time of publication it was a bold and daring work, in sweep of conception without precedent; it remains, a little more than two hundred pages in extent—an impressive epitome of a field which it is unlikely will ever be reviewed in a single volume again.

In the early 'thirties, feeling the need for developing his ideas in the freer climate of the academic world, Meyer moved to the University of Geneva as professor of organic and inorganic chemistry. As chief 'assistant' he brought with him Dr. A. J. van der Wyk, and was always the first to acknowledge how much he owed to his second-in-command, not only for constructive criticism but also, as shown by their many works of collaboration, in the formal elaboration of his ideas.

During the war-years he again reviewed the field of high-polymer chemistry in his "Natural and Synthetic High Polymers", with its remarkable sub-title, "A Textbook and Reference Book for Chemists and Biologists". Never before had the biologist found himself in such distinguished company. The second edition of this work, published in 1950, probably reached the limit of one man's ability to review a field which in twenty years had become the province of new and major industries, and had shown itself to be the proper science of many of the oldest arts and crafts of mankind. To every part of that field contributions had been made by Meyer and his school in Geneva. The diversity of his interests was such that few of his colleagues can have been familiar with all aspects of his work. In Great Britain he is probably best known for that series of researches which led to the kinetic theory of rubber-like elasticity, researches covering an extraordinary range of materials, from plastic sulphur, amorphous selenium and other inorganic elastomers, through rubber and synthetic plastics to natural products, such as collagen, elastin, keratin and muscle itself. Of scarcely less general interest was his work on polysaccharides: on the structure of cellulose, on the permeability of cellulose membranes, on polysaccharides containing amino-sugars, and on the constitution and enzymatic breakdown of starch. To these may be added pioneer work on the crystallography of peptides, on narcotics, recent work on hormones, and a series of papers on the properties of high polymers in solution.

Kurt Meyer had a unique sympathy for and interest in the biological field, and he saw, as no chemist before him, that morphological chemistry is as intimately related to plant and animal morphology as it is to physiology. He was essentially a morphologist himself: he believed intensely in the value of three-dimensional models of molecular structure as a means of refining concepts (by providing a concrete picture for criticism), and as a means of limiting the immediate field of inquiry. Those who worked with him will remember his infectious enthusiasm and tireless energy, and that fertility in hypothesis which he restrained by constant appeal to evidence obtained by the application of as wide a range of techniques as possible: X-ray analysis, studies of elastic and thermo-elastic properties, viscosity and solubility data, chemical analyses—any model must take into account all these; to rely on one technique was to court disaster. The biologist will remember that in papers as early as 1929, as well as in his book with Mark, Kurt Meyer pointed the way to a new cytology; for he saw, perhaps more clearly than anyone else at that time, the relevance of the growing field of high-polymer chemistry to biology.

L. E. R. PICKEN

Prof. F. H. Newman, C.B.E.

FREDERICK HENRY NEWMAN was born in Bath in 1891 and his first school was St. Saviour's, Bath, whence he went by scholarship to the City of Bath Boys' School in 1904. In 1911 he entered the Royal College of Science, London, graduated in 1913 and, after a further year of research, became an assistant lecturer at University College, Aberystwyth. In 1916

he joined the Royal Warwicks and afterwards the Scottish Rifles, being demobilized in 1919 with the rank of captain.

Newman's appointment in 1919 as lecturer in physics at University College, Exeter, began an association which continued until his death on April 15. The early years at Exeter were very full ones, and to an exceptionally heavy programme of lecturing and practical class supervision he somehow added a great deal of research work which was described in a continuing flow of papers during the decade 1920-30. They were concerned mainly with absorption and the spectroscopy of discharge tube effects, and the degrees of M.Sc., Ph.D. and D.Sc. followed in successive years.

In 1922 he was promoted to the chair of physics at Exeter, and at the time of his death he was also director of the Washington Singer Laboratories and acting principal of the College. For his numerous public services during and after the Second World War he was awarded the C.B.E. in the 1949 King's Birthday honours.

His publications include "The Production and Measurement of Low Pressures" (1925), "Electrolytic Conduction" (1931), "Recent Advances in Physics" (1931) and, in collaboration, "The General Properties of Matter" (1929).

Newman's earliest, and always his foremost, interest was his students, of whom his continuing remembrance was remarkable. From the institution of an honours school in 1920 to the end of his career, their welfare was his main concern, and the Department which he shaped is a not unworthy memorial. To many a physicist it is a matter of pride to be able to claim to have been one of Newman's men.

VICTOR H. L. SEARLE

NEWS and VIEWS

Royal Society: New Foreign Members

AT a meeting of the Royal Society held on May 1, the following were elected foreign members of the Society: Prof. Sven Hörstadius, professor of zoology, University of Uppsala; Prof. Albert Jan Kluyver, of Delft; Prof. Albert Marcel Germain René Portevin, of Paris; and Prof. Tadeus Reichstein, of the University of Basle.

Prof. Sven Hörstadius

PROF. SVEN HÖRSTADIUS is an experimental zoologist whose researches are so fundamental that they mark an epoch. By means of operations involving the removal, grafting and substitution of blastomeres of sea urchins, he has demonstrated objectively for the first time the existence of levels of quality (gradients) of differentiation coinciding with the axis of the egg. Applying the results of this analysis, and selecting appropriate combinations of blastomeres, artificially assembled by him, he has been able to produce embryos with all desired degrees of normality and abnormality under rigorously controlled conditions. In other experiments involving fertilization of enucleated eggs of one species of sea urchin by sperm of another, and, taking one blastomere of such larval hybrids and grafting it into an embryo of the species of egg, he has been able for the first time to demonstrate the properties of the matter contained in a single nucleus in determining the quality of differentiation of the resulting embryo. He has applied the same analysis to other embryonic material, for example, from the Nemertines. He has also analysed the factors which determine the orientation of the mitotic spindles in sea urchin eggs and obtained positive results which have enabled him to produce modes of cleavage at will. Turning his attention to vertebrate material, Prof. Hörstadius has been able not only to demonstrate the power of different regions of the neural crest of newt embryos to differentiate into the various structures to which it gives rise, but also to show how the quality of such differentiation is determined by the presence of other structures. This is the first time that the phenomenon of complex and additive inductive action by different structures has been demonstrated under controlled conditions. Finally, it should be emphasized that, in spite of the almost incredible difficulties of the operative techniques used, Prof. Hörstadius's results are based, not on small numbers, but on hundreds, of experiments.

Prof. A. J. Kluyver

PROF. A. J. KLUYVER, president of the Royal Netherlands Academy of Sciences, became professor of microbiology at the Technische Hoogerschool at Delft in 1924. At that time such knowledge as was available concerning the chemical activities of bacteria was bewildering in its diversity. Kluyver's insight prompted him to believe that all this variety of activity was based upon a fundamental unity in biochemical activity, and that the organized study of the reactions of micro-organisms should have a contribution of immense importance to make to the study of the fundamental chemistry of the living cell. In a series of lectures given in the University of London in 1930, he put forward a masterly synthesis of the facts then known about bacterial metabolism, and emphasized that such studies of 'comparative biochemistry' should have the same influence on the development of biochemistry as studies of comparative anatomy had had on the development of anatomy as a science. The comparative aspect was the basis of the studies of the Delft school on the bacterial metabolism of carbon compounds and led to the rise of modern microbiology and its relation to biochemistry. Many of the reactions postulated by Kluyver twenty years ago have now been disproved; but the truth of his belief in biochemical unity has been amply demonstrated during recent years, while the inspiration of his approach is acknowledged in biochemical and microbiological laboratories throughout the world. Prof. Kluyver is best known to microbiologists in Great Britain for his clear-sighted and lucid expositions of the chemical principles underlying bacterial metabolism, which he has continued to give on such occasions as the inauguration last year of the Microbiological Panel of the Society of Chemical Industry.

Prof. A. M. Portevin

PROF. A. M. Portevin, who was born in Paris in 1880, has had a career characterized by wide interests

in industry, scientific research, education and scientific publication. Trained originally as an engineer, he first held the post of director of the laboratories of the Dion–Bouton motor works from 1905 until 1912. The years 1912–25 were spent as lecturer and later professor at the École Centrale des Arts et Manufactures, and in 1931 he became professor at the École Supérieure de Soudure Autogène, Paris. His scientific work has been mainly in physical metallurgy, with particular reference to the properties of steels. His work on the transformation of steels, both carbon steels and alloy steels, is classical; it defined the nature of these transformations, and, in particular, indicated the role of alloying elements in alloy steels. Later he turned his attention to the transformations in the light alloys of aluminium, and made substantial contributions to the theory of these reactions. He has worked extensively on the solidification of metals, dealing in particular with the principles governing the solidification of metals in moulds and the property of 'castability', and he has devoted much attention to the study of autogenous welding. In association with Prof. Chevenard he has made extensive studies of volume changes in alloys and has perfected methods of dilatometric analysis which have been widely used, particularly in France, in the exact study of transformations in alloys. He has also worked on the thermal analysis of complex systems, on inclusions in metals, on corrosion, and on the distribution of stress in metal structures under load, while his systematic study of microstructures and their classification has been a particularly valuable contribution to physical metallurgy. Prof. Portevin's published papers are a model in clear expression and reveal a beautiful command of language. For forty-five years Prof. Portevin has been associated with the French periodical *Revue de Métallurgie*, of which he is now technical director, and he has been responsible for maintaining the high standard of this well-known scientific journal. In the course of a long and distinguished career, Prof. Portevin has received many honours from universities and scientific and technical societies throughout the world. He is a Commandeur de la Légion d'Honneur, a Commandeur de l'Ordre de la Couronne de chêne de Luxembourg, and a member of the Institute of France.

Prof. T. Reichstein

Dr. T. Reichstein is professor in the Institute of Organic Chemistry in the University of Basle. The importance of his investigations in the steroid field was recognized by the award jointly to him and to Drs. Philip S. Hench and Edward C. Kendall of the Nobel Prize for Medicine in 1950. But it is not in the steroid field alone that Prof. Reichstein has made outstandingly distinguished contributions. His researches into the structure of ascorbic acid led to his synthesis of this substance in 1933, by a method which formed the basis for the early large-scale production of this vitamin. He has continued to display his amazing ability in the field of carbohydrate chemistry by the elucidation of the chemistry, usually accompanied by synthesis, of many rare sugars. It is in the field of steroids, particularly with respect to heart poisons and adrenal hormones, that Prof. Reichstein has made his most famous contributions. His partial synthesis of 11 deoxycorticosterone in 1937, and his isolation of corticosterone from adrenal tissue in the same year, were landmarks in this field of investigation, and from 1943 onwards his partial synthesis of the corticosterone-like series of adrenal steroids opened up possibilities which are still being explored. It was Prof. Reichstein's earlier researches that made ultimately possible the large-scale production of cortisone, a substance that has become of great importance in the treatment of rheumatoid arthritis and other diseases. Prof. Reichstein is still a comparatively young man, and it may confidently be expected that his outstanding contributions to the chemistry of products of natural importance will continue for many years to come.

Institution of Mining and Metallurgy: Awards

The Institution of Mining and Metallurgy has recently made the following awards: *Gold Medal of the Institution*, to Dr. G. K. Williams, in recognition of the importance of his work in connexion with research into the metallurgy of lead and zinc and the development of metallurgical processes; "*The Consolidated Gold Fields of South Africa, Limited*" *Gold Medal*, to H. E. Jeffery, for his paper on fire prevention and fire-fighting, with particular reference to the Kolar Gold Field (*Trans.*, **60**); "*The Consolidated Gold Fields of South Africa, Limited*" *Premium of Forty Guineas*, jointly to R. Cornthwaite and F. Juretic, for their paper on the sinking of an Irwin shaft at Roan Antelope copper mine (*Trans.*, 60); "*Arthur Claudet*" *Student's Prize*, to T. A. A. Quarm, for his paper on a method for the preparation of high-purity indium metal (*Trans.*, **60**); and the "*William Frecheville*" *Student's Prize*, to A. P. Millman, for his part-authorship of the paper on heavy metals in vegetation as a guide to ore—a biogeochemical reconnaissance in West Africa (*Trans.*, 60). Honorary membership of the Institution has been conferred on E. Hooper, past-president, in recognition of his services in the development of the Institution from its foundation sixty years ago, and on E. D. McDermott, past-president, in recognition of his services to the Institution and to mining and metallurgical education.

Scientific Research and Defence

The debate on defence in the House of Lords on April 23 provided no answer to the question whether Britain is using scientific men to the best possible effect in defence work. Lord Alexander of Hillsborough, in opening the debate, questioned the desirability of the Ministry of Defence being a rapidly expanding department; he urged that the critical question facing us to-day is that of the point in economic expenditure when we reach the limit of safety and security, and that we must be careful that we do not show that free nations can defend themselves only at the expense of bankruptcy. He raised one specific point of scientific interest regarding the value of the helicopter in anti-submarine; in reply, the Minister of Defence, Lord Alexander of Tunis, stated that it would be very useful for the visual detection of submarines in coastal waters. As regards research, the Minister of Defence stated that we are now employing many more scientific men on defence problems than we did before the Second World War, and they are making a remarkable contribution to our defence effort. The most important innovations usually result, he said, through scientific workers and engineers detecting the possibility of an extension or technical application of scientific knowledge, and the best results are achieved when the military officer and the technical expert meet on a footing of equality to pool their ideas. He believes that our

present arrangements secure an integration of military and scientific effort at least as good as anything which exists in any other country. The close co-operation ensures that our resources in science and technology are fully applied to the improvement and equipment of the Services, while co-operation between operational research scientific workers and the fighting men ensures the best use of the weapons we have.

The Defence Research Policy Committee effects a proper allocation of resources between the different Services and their various projects, and in this connexion Lord Alexander paid a tribute to the work of Sir Henry Tizard. The right policy, Lord Alexander believes, is to go into immediate production in quantity when we think we have found something really good and not delay in the hopes of finding something still better. The danger lies in dispersing our effort on all kinds of interim equipment. Lord Pakenham, who expressed doubts as to whether we are making full use of our potential supply of scientific workers, said that, in his opinion, the Admiralty does not employ as many scientific men as it should; in reply, the Secretary of State for Air stated that there is no intention of reducing the number of scientific workers used by the Admiralty, but for security reasons he was unable to supply Lord Winster with the information he requested regarding development and research on guided missiles; nor did he deal with the question of political warfare and the contributions of the British Broadcasting Corporation and the British Council, which were raised by Lord Kenswood.

Register of Biological Consultants

THE Institute of Biology has recently established a Register of Biological Consultants. Subjects covered by biologists on the register include agronomy, bacteriology, biochemistry, ecology, entomology, fisheries, forensic biology, histology, microbiology, nutrition, pest control, protozoology, river pollution, and wild-life conservation. The Institute is now in a position to recommend specialist advisers in any branch of the biological sciences to those requiring their services. Inquiries should be addressed to the General Secretary, Institute of Biology, Tavistock House South, Tavistock Square, London, W.C.1.

Harwell Unclassified Reports

FIFTY-ONE unclassified scientific reports issued by the Atomic Energy Research Establishment, Harwell, are now available (London: H.M.S.O.). As the director, Sir John Cockcroft, has recently pointed out, much of the scientific work carried out at the Establishment is published in the regular scientific periodicals; indeed, more than a hundred articles have appeared in the past year. Nevertheless, the general availability of these scientific reports is most welcome, since they not only indicate the wide range of problems dealt with at Harwell but also show that atomic research, in spite of the fact that some of its results must, because of their military importance, remain secret, makes a very large contribution to the advance of the physical and medical sciences. The reports are not limited to nuclear processes, but deal with a variety of subjects, including vacuum appliances and techniques, electronic instruments, temperature measurement and statistical and mathematical methods. The March issue of the *Atomic Scientists News* (1, 177; 1952) prints a list of the reports.

Society of General Microbiology

AT the annual general meeting of the Society for General Microbiology, held at Oxford on April 15, the following officers were appointed for 1952–53: *President*, Mr. H. J. Bunker; *Honorary Secretaries*, Dr. J. G. Davis (general) and Dr. E. F. Gale (meetings); *Honorary Treasurer*, Dr. R. Lovell; *Honorary Editors*, Prof. B. C. J. G. Knight and Mr. A. F. B. Standfast. A very successful symposium on "The Nature of Virus Multiplication" was held during April 16–17 and attended by more than three hundred microbiologists; the papers and discussion in this symposium will be published in book form under the editorship of Sir Paul Fildes and Dr. W. E. van Heyningen. Information about the Society can be obtained from Dr. J. G. Davis, 52 London Road, Reading, Berks.

Histochemical Society

AT a meeting of the Histochemical Society in New York on April 7–8 the following officers and councillors were elected: *President*, Dr. Stuart Mudd (University of Pennsylvania); *Vice-President*, Dr. J. Walter Wilson (Brown University); *Secretary*, Dr. Ralph D. Lillie (National Institutes of Health, Bethesda); *Treasurer*, Dr. Edward W. Dempsey (Washington University); *Councillors for four years*, Dr. Arnold Lazarow (Western Reserve University) and Dr. Albert H. Coons (Harvard University). At the meeting, sixty-two new members joined the Society, and Prof. R. R. Bensley (University of Chicago) and Dr. L. Lison (University of Brussels) were elected to honorary membership.

Society for Endocrinology: Officers and Committee

OFFICERS and the committee of the Society for Endocrinology have been elected as follows: *Chairman*, Dr. S. J. Folley; *Honorary Secretaries*, Prof. C. H. Gray and Prof. N. F. Maclagan; *Honorary Treasurer*, Dr. F. L. Warren; *Editor of the Society's Proceedings*, Prof. S. Zuckerman; *Ordinary Members of Committee*, Dr. E. C. Amoroso, Dr. G. W. Harris, Dr. C. J. O. R. Morris and Dr. S. L. Simpson. Communications should be sent to Prof. C. H. Gray at the Department of Chemical Pathology, King's College Hospital, Denmark Hill, London, S.E.5.

Second International Congress of Biochemistry, Paris

THE Second International Congress of Biochemistry will be held in the Sorbonne, Paris, during July 21–27, under the presidency of Prof. R. Fabre, with Prof. G. Bertrand as president of honour. The programme has been arranged in seven sessions as follows: biochemistry of hæmatopoiesis; biogenesis of proteins; tricarboxylic acid cycle; protein hormones and hormones derived from proteins; bacterial metabolism; mode of action of the antibiotics; and biochemistry of steroids. The following general lectures will be given to the Congress: Prof. J. N. Davidson, nucleoproteins and tissue growth; Prof K. Linderström-Lang, proteins and enzymes; and Prof. S. Ochoa, carbon dioxide fixation in animals and plants. Further details can be obtained from the general secretary of the Congress, Prof. J.-E. Courtois, 4 Avenue de l'Observatoire, Paris, 6e.

Textile Institute: Annual Conference

THE annual conference of the Textile Institute will be held in the Assembly Rooms, George Street,

Edinburgh, during June 2–6, when the subject of "Animal Fibres" will be considered. The conference will be divided into three sections covering, respectively, blending of fibres in yarns, blending of fibres in fabrics, and dyeing and finishing of blended fabrics. In all, twenty-three papers will be read, of which eight will be from visitors overseas. Excursions will be made on June 5 to Scottish firms and textile bodies ranging from Selkirk to Dundee. Further information can be obtained from the Development Officer, Textile Institute, 10 Blackfriars Street, Manchester 3.

Third International Spectroscopy Colloquium, 1952

The Industrial Spectroscopy Group of the Institute of Physics is arranging the third International Spectroscopy Colloquium, which will be held during September 1–3. The conference will be residential and will be held at High Leigh, Hoddesdon, Hertfordshire. There will be accommodation for a few married couples; as the total attendance is limited to about 120, early application for enrolment forms is necessary. The programme will provide for papers read and discussed in eight short sessions. Two sessions will probably be devoted to progress reviews of special aspects of spectroscopy; it is hoped also to have papers on various branches of absorption spectroscopy as well as emission and direct-reading methods. All communications concerning the conference, including suggestions for speakers, should be addressed to the Honorary Colloquium Secretary, Mr. E. Van Someren, Institute of Physics, 47 Belgrave Square, London, S.W.1.

Exhibition of British Clocks, c. 1660–1820

An exhibition of the "British Clockmaker's Heritage", organized by the Antiquarian Section of the British Horological Institute, will be held in the Science Museum, London, S.W.7, during May 23–September 14 (weekdays, 10 a.m.–6 p.m., and Sundays 2.30–6 p.m.; admission free), and will be opened by H.R.H. Princess Alice, Countess of Athlone, on May 22. The exhibition will be divided into four main sections: an introductory group of clocks made before the inventions of the pendulum and balance-spring; and three larger groups showing respectively the development from about 1660 to 1820 of clocks for scientific purposes, domestic clocks, and the history of watches from about 1600 to 1820. The scope of the exhibition is not carried past 1820, since by that date the main technical features of timekeepers had become stabilized, and the artistic standards of domestic clocks had begun to fall off. In the section on clocks, of which there will be more than a hundred displayed, the names of famous craftsmen include Edward East, the Fromanteels (who introduced the pendulum into England), the Knibb family and Thomas Tompion. The marine chronometers will include three of the four famous pioneer machines of John Harrison, the Yorkshire carpenter who won the Government's prize of £20,000, offered for an accurate marine timekeeper. Finally, about two hundred watches will be shown. There will be two exhibition catalogues: a standard edition priced at 2*s*. 6*d*., and a profusely illustrated *de luxe* edition at 10*s*. 6*d*. (both obtainable from the Science Museum or from the British Horological Institute, 35 Northampton Square, London, E.C.1; postage 6*d*. extra). Both editions contain, besides informative descriptions of the exhibits, a series of articles by well-known writers on horology.

Announcements

Prof. F. A. Vick, professor of physics in the University College of North Staffordshire, has been appointed acting principal of the College until such time as a permanent appointment has been made.

Prof. W. T. Marshall, professor of engineering in the University of St. Andrews since 1946 (see *Nature*, 158, 443; 1946), has been appointed regius professor of civil engineering in the University of Glasgow in succession to the late Prof. Gilbert Cook.

The Council of the Royal Society has appointed Mr. E. M. Gunnersen, a graduate of the University of Melbourne, as the first Rutherford Scholar. He will work on nuclear physics in a university in the United Kingdom commencing on October 1, 1952, for three years.

Dr. H. Hollings will, at the end of June, relinquish his appointments as director of the London Research Station of the Gas Council and as controller of research, North Thames Gas Board. He will be succeeded by Dr. R. H. Griffith.

The Royal Dutch-Shell Group of Oil Companies is offering a research studentship in geophysics, of the value of £400 a year and tenable for two to three years at the University of Cambridge, which is open to men of any nationality less than twenty-seven years old. Further details can be obtained from Mr. B. C. Browne, Department of Geodesy and Geophysics, Downing Place, Cambridge. Applications must be completed by July 1.

The eighty-ninth annual general meeting of the Institution of Gas Engineers will be held at Church House, Westminster, London, S.W.1, during May 27–30, under the presidency of Mr. J. H. Dyde. In addition to the president's address, seven papers will be given; there will also be a number of excursions to places of interest. Further details can be obtained from the Secretary of the Institution of Gas Engineers, 17 Grosvenor Crescent, London, S.W.1.

The Development Commission is offering a few grants to British postgraduate honours students for training in research problems in marine or freshwater science, which is designed primarily to fit them for employment either in the fishery research services of the Ministry of Agriculture and Fisheries and the Scottish Home Department or in a marine or freshwater biological research institute. The grants are worth £220–300 a year, with extra university fees paid, and are tenable initially for one year, but renewable up to a maximum of three years. Application forms, to be returned by June 1, can be obtained from the Secretary, Development Commission, 6a Dean's Yard, Westminster, London, S.W.1.

A catalogue of the library of the Institut d'Études Centrafricaines, Brazzaville, has been prepared by Jeanine Lambert and issued as No. 4 of the Mémoires of the Institute (pp. 153; 1,000 francs). It consists of an author catalogue, arranged alphabetically, a subject catalogue, classified in twenty-five main divisions, with sub-divisions, according to a scheme detailed, and an alphabetical list of periodicals contained in or currently received by the library.

The forty-ninth exhibition of scientific instruments and material, organized by the French Physical Society, will be held, as in previous years, in Paris at the Sorbonne during May 29–30 and June 3–5 (2.30–6.30 p.m. and also 8.30–11 p.m.) and on May 31 (2.30–6.30 p.m.). Further details can be obtained from the Comité d'Exposition, 12 rue Cuvier, Paris 5e.

NEUTRALIZATION OF THE ANTI-*H* AGGLUTININ IN EEL SERUM BY SIMPLE SUGARS

By Dr. WINIFRED M. WATKINS and Prof. W. T. J. MORGAN, F.R.S.
Lister Institute of Preventive Medicine, London, S.W.1

In recent years an antibody present in certain natural eel (*Anguilla anguilla*) sera which agglutinates group *O* and A_2 cells preferentially has been used increasingly for studies on the blood-group activity of cells and secretions from group *O* persons. A material can be obtained from group *O* cells and from the secretions of those group *O* individuals who secrete *H*-substance, which when mixed with the *H*-agglutinin in eel serum neutralizes completely its power to agglutinate group *O* cells[1]. On the basis of our present knowledge of the specificity of serological reactions in the field of the human blood-groups, one might conclude, with some justification, that the agglutinin in eel serum reactive with group *O* cells would be inhibited only by *H*-substance. We have observed, however, that certain simple sugars will at fairly high dilutions bring about the inhibition.

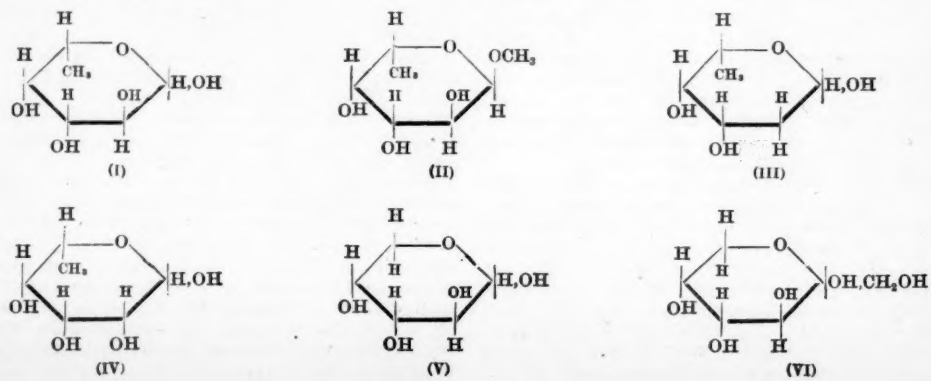
Inhibition End-points given by (*a*) *H*-substance and (*b*) Sugars with anti-*H* Agglutinin in Eel Serum

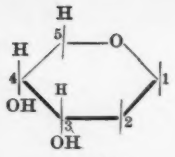
Substance	Dilution of substance giving inhibition end-point
Human *H*-substance	1 : 819,200
α-Methyl-L-fucopyranoside	1 : 51,200
L-Fucose	1 : 12,800
2-Deoxy-L-fucose	1 : 6,400
β-Methyl-L-fucopyranoside	1 : 3,200
6-Deoxy-L-talose	1 : 800
D-Arabinose	1 : 400
D-Fructose	1 : 200
D-Fucose	<1 : 50

It is known that human *H*-substance[2] contains about equal amounts of L-fucose, D-galactose, D-glucosamine and D-chondrosamine. The group substances *A*, *B* and Le^a [3] likewise contain these sugars, and it is therefore improbable that any one of these residues is responsible alone for the characteristic serological specificity of the group substances. Nevertheless, we have observed (see table) that a 0·01 per cent solution of L-fucose in saline inhibits the action on *O* cells of two to three completely agglutinating doses of the *H*-antibody in eel serum. Under similar test conditions, the purified *H*-substance brings about complete inhibition at a considerably lower concentration.

A number of sugars—D-fucose, D- and L-glucose, D-mannose, D- and L-galactose, L-sorbose, N-acetyl-D-glucosamine, N-acetyl-D-chondrosamine, L-arabinose, D- and L-xylose, D-ribose, D-allomethylose, D-altrose, α-methyl-D-altromethylose, L-gulomethylose, L-rhamnose, D-digitoxose, erythritol, dulcitol, pinitol, perseitol, inositol, sucrose, inosose, D-threose, D-mannoheptulose, D-glucoheptulose, D-manno-D-*gala* heptose, D-gluco-L-*gala* octose, D-gluco-L-*talo* octose, D-gulo-L-*gala* heptose—failed to inhibit at a concentration of 2 per cent when tested similarly, and solutions of dextran (10 per cent), gum arabic (0·5 per cent), heparin (2 per cent), glycogen (0·5 per cent), galactocarolose (2 per cent), mannocarolose (0·5 per cent) and sodium hyaluronate (0·5 per cent) were likewise inactive. The inhibition given by L-fucose, therefore, shows considerable specificity. Polysaccharides known to contain L-fucose, fucoidin, gum tracaganth and jelly-coat substance of the sea urchin's egg[4], as well as the blood-group Le^a substance, showed no capacity, however, to neutralize the *H*-agglutinin in eel serum. The inhibition shown by purified *A* and *B* substances when tested at relatively high concentrations does not necessarily mean that the *A* and *B* specific structures react with the eel serum, since these preparations have not yet been obtained completely free from *H*-activity. L-Fucose failed to inhibit the agglutination of *O* cells by other anti-*H* sera[5] as exemplified by selected natural cattle sera, serum from rabbits immunized with human *H*-substance, serum from chickens and goats immunized with *Shigella shigæ* or an anti-*H* serum of human origin. Inhibition of eel serum with L-fucose, therefore, provides additional evidence that *H*-antibodies of different origin are not identical[6]. L-Fucose likewise was inactive when tested in the systems (1) *A* anti-*A*, (2) *B* anti-*B*, (3) Le^a anti-Le^a, (4) Le^b anti-Le^b, using the corresponding antibody of human or animal origin.

The examination of sugars possessing structures similar or closely related to that of L-fucose (I) revealed that α-methyl-L-fucopyranoside (II) was more active than the parent sugar, whereas β-methyl-L-fucopyranoside and 2-deoxyfucopyranose (III) were less active. 6-Deoxy-L-talose (IV), D-arabinose (V), and the corresponding α- and β-methyl D-arabinosides and D-fructose (VI) also showed slight inhibiting activity.





(VII)

The structure (VII), which is common to all the sugars shown to possess some capacity to combine with the anti-*H* agglutinin in eel serum, is a pyranose ring with *cis* OH groups below the plane of the ring at carbon atoms 3 and 4 and a hydrogen atom above the plane of the ring at carbon atom 5.

The nature of the substituents occupying the remaining positions in the ring influences the degree of inhibition obtained, and the closer the relationship to L-fucose the greater is the degree of inhibition. Thus replacement of the methyl group in L-fucose by a hydrogen atom to give D-arabinose (V) results in decreased activity, and replacement by CH_2OH as in L-galactose, or by —CHOH—CH_2OH as in D-gulo-L-*gala* heptose, or —$(CHOH)_2$—CH_2OH as in D-gluco-L-*gala* octose, leads to complete loss of power to inhibit. When the groups attached to carbon atom 2 are considered, it is found that replacement of hydroxyl by hydrogen to give 2-deoxy-L-fucose (III) or the reversal of the configuration of the hydrogen–hydroxyl group to give 6-deoxy-L-talose (IV) leads to a structure which shows decreased power to inhibit compared with L-fucose. Replacement of the methyl group at carbon atom 5 by a hydrogen atom together with reversal of the configuration at carbon atom 2 to give D-ribose results, however, in complete loss of the capacity of the sugar to neutralize the agglutinating activity of the eel serum. Reversal of the hydrogen–hydroxyl configuration at carbon atom 3, as in L-gulo-methylose, results in almost complete loss of power to neutralize, and it seems possible that a similar change at carbon atom 4 would lead to complete inactivity. L-Glucomethylose was not, however, available for test. On the basis of the results so far obtained, it would appear, therefore, that the configuration which gives the closest fit with the antibody in eel serum is that of α-methyl-L-fucopyranoside, but certain limited changes in the structure are possible without complete loss of activity. The fact that the inhibition given by L-fucose is considerably less than the activity of the intact *H*-substance shows that this sugar alone does not account for the complete specificity of the blood-group hapten. The greater activity of the α-methyl-L-fucopyranoside in comparison with the parent sugar and the reduced activity of the anomer, β-methyl-L-fucopyranoside, indicates that the α-glycoside bond enhances the activity of the specific structure. This observation, perhaps, suggests that in the *H*-substance, as it exists on the erythrocyte surface and in secretions, the fucose residues are bound to the rest of the molecule through α-glycoside linkages.

Instances of a simple carbohydrate bringing about the inhibition of precipitation of a specific polysaccharide by an immune serum have been reported by Goebel and by Marrack in their immunochemical studies. For example, Marrack[7] showed that the heterologous precipitation reaction between weakly hydrolysed gum acacia, cherry gum or mesquite gum and an immune type II pneumococcal serum was inhibited by glucuronides or salts of glucuronic acid, which is a component residue of these gums. Similarly, Goebel[8] has shown that the precipitation of an artificial antigen made from type III pneumococcus polysaccharide by type II or type VIII anti-pneumococcal horse serum is inhibited by *p*-aminobenzyl-β-cellobiuronide. Cellobiuronic acid is the sole repeating residue in the type III polysaccharide. So far as we are aware, however, inhibition of specific antigen–antibody reactions, in which both components occur naturally, by a simple sugar, has not previously been demonstrated.

The implications inherent in the observation that simple sugars bring about inhibition can have practical significance. Inhibition of the agglutination of cells by a naturally occurring heterologous serum brought about by biological materials of unknown composition, such as secretions or cell extracts, is usually interpreted as indicating the presence of a specific hapten or antigen. It is evident, however, that the observed inhibition may be due to the presence of a simple sugar which need not be even a constituent of the hapten or antigen but merely possess a close structural relationship to a component in these complexes.

We are grateful to Dr. C. S. Hudson, Dr. J. K. N. Jones and Prof. T. Reichstein for certain of the rare sugars used in this investigation.

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[8] Goebel, W. F., *J. Exp. Med.*, **68**, 469 (1938).

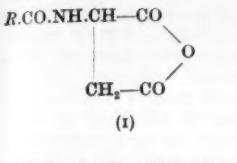
ANHYDRIDES OF N-ACYLASPARTIC AND N-ACYLGLUTAMIC ACIDS

By Dr. J. M. SWAN

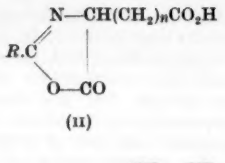
Biochemistry Unit, Wool Textile Research Laboratory, Commonwealth Scientific and Industrial Research Organization, Melbourne

A RECENT communication by Barker[1] dealing *inter alia* with the structure of the anhydride of N-acetylaspartic acid prompts me to record my results in an investigation of this compound, and of some analogous glutamic acid derivatives.

I have found, as did Barker, that acetylaspartic acid anhydride[2,3] possesses the true anhydride (I) rather than the oxazolone (II, $n = 1$) structure. Reaction with aniline gives two isomeric anilides, melting points 202° and 178° respectively (Barker reports melting points 199° and 176–79°, decomp.). Of these, the first is the α-anilide, recovered unchanged after heating with acetic anhydride and ammonium thiocyanate, while the other isomer gives 1-acetyl-2-thiohydantoyl-5-α-acetanilide (III; $R = CH_3$, $R' =$ Ph, $n = 1$). Conversion to a thiohydantoin in this way is a characteristic reaction of the CO.NH.CH*R*.CO_2H group[4,5].



(I)



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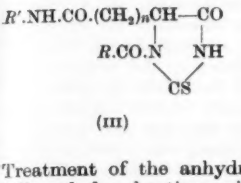

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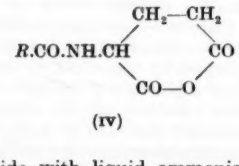


(IV)

Treatment of the anhydride with liquid ammonia, followed by heating with acetic anhydride and ammonium thiocyanate, gives 1-acetyl-2-thiohydantoyl-5-α-acetamide (III; $R = CH_3$, $R' = H$, $n = 1$), identical with the product obtained directly from asparagine[6]. Acetyl-DL-aspartic acid α-amide is also isolated from the reaction[1].

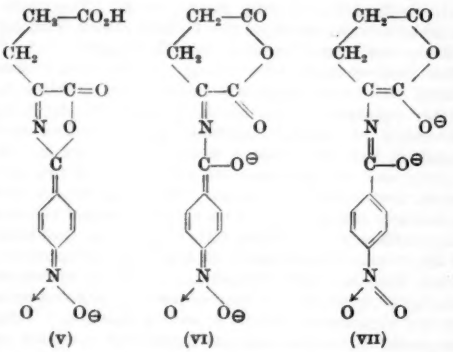
Similar experiments by Nicolet[6] had already shown that acetylglutamic acid anhydride possesses the structure (IV) rather than the oxazolone structure (II; $R = CH_3$, $n = 2$)—reaction of the anhydride with aniline and with ammonia gave products shown to contain the γ-isomers by preparation from it of the corresponding thiohydantoins (III; $R = CH_3$, $n = 2$, $R' = Ph$ and H respectively). The thiohydantoin (III; $R = CH_3$, $R' = H$, $n = 2$) was identical with the substance obtained directly from glutamine by Thierfelder[7], who recognized the diagnostic value of the thiohydantoin reaction for deciding alternative structures in this series.

Two papers have appeared recently in which the oxazolone formulation (II, $n = 2$) is postulated for an acylglutamic acid anhydride. Baker and Jones[8] prepared a dehydro-N-phenylacetyl-L-glutamic acid by heating the acid with acetic anhydride, and ascribed to it the formula (II; $R = PhCH_2$, $n = 2$) on the basis of loss of optical activity alone. The amide and hydrazide derived therefrom were regarded as α-derivatives without further investigation. King and Spensley[9] similarly prepared a racemic anhydride from *p*-nitrobenzoyl-L-glutamic acid, formulated as (II; $R = p\text{-}O_2N.C_6H_4$, $n = 2$), proof of structure being claimed on the basis of (1) the loss of optical activity, (2) the intense violet-blue colour observed on contact with alkalis, and (3) the formation of α-derivatives on reaction with ammonia and with benzyl alcohol.

I have now found that both these substances are true anhydrides (IV; $R = PhCH_2$ and $R = p\text{-}O_2N.C_6H_4$ respectively). The phenylacetyl compound gives two anilides on reaction with aniline, melting points 159° and 195°, of which the first only (the γ-compound) can be converted to a thiohydantoin. Reaction with acetic anhydride and ammonium thiocyanate of Baker and Jones's[8] "phenylacetyl-DL-glutamic acid α-amide", melting point 144–46°, gives 1-phenylacetyl-2-thiohydantoyl-5-β-propionamide (III; $R = PhCH_2$, $R' = H$, $n = 2$), thus proving the compound to be actually the γ-amide. The true α-amide has also been found, melting point 133–34°. Repetition of Baker and Jones's preparation of "phenylacetyl-DL-glutamic acid α-hydrazide", described as having melting point 181° (decomp.), has given two isomers, melting points 183–84° (without decomposition) and 147°. In this case the formulation of the higher-melting substance as the α-hydrazide is correct, as shown by the preparation from it of the above α-anilide.

The *p*-nitrobenzoyl-DL-glutamic acid anhydride likewise gives two anilides with aniline, melting points 245° and 199–200°, of which only the latter can be converted to the corresponding 1-*p*-nitrobenzoyl-2-thiohydantoyl-5-β-propionanilide (III; $R = p\text{-}O_2N.C_6H_4$, $R' = Ph$, $n = 2$). Similarly, liquid ammonia gives two isomeric amides, melting points 195–96° and 188–90°. The first of these corresponds to King and Spensley's *p*-nitrobenzoyl-DL-glutamine, melting point 191–93°, prepared in another way, and further proof of structure has been obtained by preparation from it of the corresponding thiohydantoin (III; $R = p\text{-}O_2N.C_6H_4$, $R' = H$, $n = 2$). The second isomer is recovered unchanged from a thiohydantoin reaction. King and Spensley give melting point 185° for *p*-nitrobenzoyl-DL-glutamine, which was the only product recorded by them from reaction of the anhydride with ammonia.

Although *p*-nitrobenzoyl-DL-glutamic acid anhydride gives an intense purple colour when covered with cold 2*N* ammonium bicarbonate, the solid dissolves only slowly, with simultaneous fading of the colour. This is evidence against the oxazolone formulation, which exhibits a free carboxyl group. The acetyl- and phenylacetyl-analogues similarly dissolve only slowly in bicarbonate solution. Karrer and Keller[10] have suggested that the purple colour observed during reaction of glutamic acid with *p*-nitrobenzoyl chloride in alkali (the basis of the Waser[11] test for α-amino-acids) is due to the anion (V). In view of the above results, the alternative ionic structures (VI) and (VII) must now also be considered. Structure (VII) is exactly analogous to that proposed by Barker[1] for the anion of benzoyl-DL-aspartic acid anhydride, the solution of which in alkali has an intense blue fluorescence in ultra-violet light.



(V) (VI) (VII)

The above results show that the presence or absence of optical activity in anhydrides derived from N-acyl-L-glutamic acids is no guide to the nature of the products. Racemization probably occurs by enolization of the anhydride itself; alternatively, as mentioned by Barker[1] in discussing the N-acyl-aspartic acids, other anhydro-products may be present at equilibrium in solution. However, attempts to demonstrate the presence of oxazolones were unsuccessful. No thiohydantoin is obtained when acetyl-, phenylacetyl, or *p*-nitrobenzoyl-glutamic acid, or acetylaspartic acid, is heated with acetic anhydride containing ammonium thiocyanate; or from the corresponding anhydrides with ammonium

thiocyanate in acetic acid; while oxazolones with structures analogous to (II) yield thiohydantoins very readily under these conditions[12].

The catalytic effect of sodium acetate on the racemization of acetyl-L-aspartic acid, noted by Barker, has also been observed with carbobenzyloxy-L-aspartic acid[13], the product again being a true anhydride.

A more complete account of these investigations will be published in the *Australian Journal of Scientific Research*, Series A. [Jan. 29.

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CATIONIC POLYMERIZATION AND RELATED PROBLEMS

MORE than eighty chemists from universities, research associations and industry were present at a conference on cationic polymerization and related problems held at the University College of North Staffordshire during March 24–26. The members included visitors from the United States, France, Holland, the Irish Republic and Germany.

The first session (chairman, D. D. Eley) was devoted to those complexes which are related to cationic catalysis. D. D. Eley and P. J. King (University of Bristol) showed that benzene and aluminium bromide form a weak 1 : 1 complex. In the presence of hydrogen bromide two phases are formed, the upper one weakly, the lower one (red oil) strongly conducting. The composition of the red oil approximates to $Al_2Br_6.HBr.6C_6H_6$. G. Baddeley and D. Voss (Manchester College of Technology) showed that a third component such as hydrogen bromide is necessary for the formation of complexes between aluminium bromide and aromatics. They have found the rate of isomerization of *p*-xylene to *m*-xylene by aluminium bromide to be proportional to the concentration of hydrogen bromide. No toluene or tri-methyl benzenes are formed, showing that the isomerization is an intra-molecular process. F. Fairbrother (University of Manchester) said that vapour-pressure studies have shown that pentene-2 does not form a complex with aluminium bromide. N. M. Cullinane (University College, Cardiff) reported the isolation of the complexes $C_6H_6.3TiCl_4$ and $C_6(CH_3)_6.3TiCl_4$. D. D. Eley and H. Watts reported the isolation as colourless crystals of $C_5H_5N.AlX_3$ and $(CH_3)_3N.AlX_3$, where X is chlorine, bromine or iodine, and of $(C_2H_5)_3N.AlCl_3$. The melting points of the complexes depend mainly on the nature of the base. The dissociation energies of the pyridine–AlX_3 complexes for X = Cl, Br and I are respectively 32, 32 and 70 kcal./mol. T. R. E. Devlin and D. C. Pepper (Trinity College, Dublin) reported the isolation of the complexes $SnCl_4.3H_2O$, .3EtOH, .2EtOH, $.2Me_2CO$ and $.2Et_2O$. The last three of these will initiate the polymerization of styrene in dichlorethane or nitrobenzene, but not in benzene. A mono-hydrate of stannic chloride could not be isolated. H. A. Skinner (University of Manchester) examined the energetics of co-ordinate link formation, emphasizing the parts played by the electron affinity of the acceptor and the ionization potential of the donor in relation to the stability of the complex. Some complexes of boron trifluoride to oxygen- and nitrogen-containing donors were used for illustrating the potentialities of the scheme proposed. J. Chatt (Imperial Chemical Industries, Ltd.) discussed the complexes of olefins with platinum and contrasted them with the silver-olefin complexes, which were then discussed in detail by G. Salomon (Rubber Stichting, Delft). The discussion centred mainly around the nature of the various types of linkage involved in these complexes.

The second and third sessions (chairman, D. C. Pepper) were devoted to the polymerization of arylenes. D. C. Pepper, working with styrene—stannic chloride—dichlorethane, found that rigorous drying increases the rate of reaction. A. Somerfield (Dublin), using stannic bromide in the same system in place of stannic chloride, found that the addition of hydrogen bromide increases the rate, reduces the molecular weight, and removes the induction period. With both catalysts the rate is proportional to [catalyst] × [styrene]^2 for styrene concentrations up to 1·74 mol./l. G. Williams and K. Heald (Royal Holloway College, London) found that the polymerization of styrene by stannic chloride in carbon tetrachloride is temporarily but completely inhibited by hydrogen chloride, due to the formation of 1-phenyl ethyl chloride. F. S. Dainton *et al.* (University of Leeds) reported that, in the system styrene—stannic chloride—carbon tetrachloride, water is not a co-catalyst. The rate is proportional to the catalyst concentration, and with respect to styrene the reaction is almost third-order in the range 0–1 *M* and second-order in the range 1–4 *M*. For α-methyl styrene—stannic chloride—ethyl chloride they found that water is a co-catalyst and that at constant water concentration the rate $= k_1$[stannic chloride]$^{1\cdot5}$ × [monomer]^y, where y varies from 1 at low monomer concentration to higher values at high monomer concentration. The degree of polymerization is $2 + k_2[m]_0$, where $[m]_0$ is the initial monomer concentration. Prof. Dainton showed that, if one assumes that the propagation-rate constant depends on the chain-length, the variable order of reaction with respect to the monomer can be explained. P. H. Plesch (University College of North Staffordshire) showed that the polymerization of styrene by titanium tetrachloride in dichlorethane is greatly accelerated by traces of water, but will proceed in its absence. He has found in addition, by infra-red analysis of end-groups, that dichlorethane, ethyl bromide, *iso*propyl bromide and *tert.*-butyl bromide probably act as co-catalysts and that, when styrene is polymerized by titanium tetrachloride in toluene with trichloracetic acid as co-catalyst, the low polymer obtained contains tolyl end-groups. He has also shown that the dielectric constant of the solvent is not the only, or even the most important, property of the solvent which influences the rate of polymerization. D. O. Jordan and A. R. Mathieson (University of Nottingham) reported on the polymer-

ization of styrene in carbon tetrachloride and of α-methyl styrene in carbon tetrachloride and ethyl chloride by aluminium chloride. For these systems they have found that the rate is proportional to the first power of the catalyst and of the monomer concentrations, that neither water nor hydrogen chloride acts as co-catalyst, that the catalyst becomes inactivated, and that solvent transfer occurs. D. Clark (University of Birmingham) reported that the polymerization of styrene by boron trifluoride in carbon tetrachloride will not proceed in the absence of a co-catalyst and that it is very sensitive to traces of water, which is a co-catalyst. It was stated by R. O. Colclough (University of Leeds) that, when styrene is polymerized in nitrobenzene or *cyclo*hexane by antimony pentachloride containing radioactive antimony, the catalyst does not remain attached to the polymer, even when this is purified under anhydrous conditions. Most of those engaged on this work were agreed that the polystyrenes and *poly*-α-methyl styrenes contain few, if any, double bonds and that the end-groups are probably substituted indanes. D. S. Brackman and P. H. Plesch said that, contrary to earlier work by others, they have been unable to isomerize *cis*-stilbene by boron trifluoride or titanium tetrachloride. In the absence of a co-catalyst there is no reaction; in the presence of one, both *cis*- and *trans*-stilbene polymerize. For the system *trans*-stilbene–titanium tetrachloride–trichloracetic acid, the polymerization is zero-order in monomer up to high degrees of conversion, but these constant rates are, for a series of experiments, proportional to [titanium tetrachloride] [trichloracetic acid] [stilbene]^2. C. G. Overberger (Brooklyn Polytechnic) gave an account of the co-polymerization of various substituted styrenes by stannic chloride and showed that the monomer reactivity ratios follow, with few exceptions, the Hammett sigma constants. The monomer reactivity ratios are found to be almost independent of the temperature over the range − 20° to + 30° C., and of the dielectric constant of the solvent over the range 2·2–29·7, nor are they affected by the catalyst concentration or the presence of small quantities of water.

The fourth session of the conference was devoted to alkenes. K. E. Russell (University of Manchester) reported that, in the polymerization of *iso*butene in ethyl chloride by stannic chloride at low temperatures, water, nitroparaffins and halo-acetic acids are co-catalysts, but nitrobenzene is not. The rate is proportional to [monomer] [water] and the molecular weight to [monomer]/[water]. M. St. C. Flett (Imperial Chemical Industries, Ltd.) and P. H. Plesch demonstrated from infra-red spectra that, when *iso*butene is polymerized in hexane by titanium tetrachloride with trichloracetic acid as co-catalyst, the predominant end-group is methylene, but that there are also smaller numbers of tri-substituted double bonds and of trichloro-acetate end-groups. A. Wassermann (University College, London) discussed the polymerization of *cyclo*-pentadiene by trichloracetic acid to a highly coloured polyene. The rate in carbon tetrachloride solution is proportional to [monomer] [trichloracetic acid]^2. This polymer is a ready proton-acceptor and differs from that formed under the influence of metal halides. Possible structures for these polymers were discussed at some length. D. D. Eley and J. Saunders reported that the rate of polymerization of alkyl vinyl ethers by iodine is proportional to [monomer] $[I_2]^2$, but that at high monomer concentration the rate passes through a maximum. The rate-constant at low monomer concentrations, and the maximum rate as well as the monomer concentration at which it is attained, are functions of the side-chain. G. W. A. Rijnders and C. G. A. Schuit (K. Shell Lab., Amsterdam) discussed polymerization and cracking on silica–alumina catalysts and directed attention to the dehydrogenation reactions which may accompany cationic polymerizations. L. Wall (National Bureau of Standards, Washington, D.C.) and C. G. Overberger presented three papers by C. M. Fontana *et al.* (Socony-Vacuum Laboratories, New Jersey). It was shown that in the polymerization of propene or butene-1 by aluminium bromide at low temperatures, a high concentration of co-catalyst such as hydrogen bromide is required to give high molecular weights, whereas *iso*butene under these conditions gives polymers of low molecular weight. The distribution of molecular weight of *poly*propenes and other evidence indicate that the transfer of tertiary hydride ions plays a dominant part in these reactions.

The discussions in the second, third and fourth sessions of the conference were mainly concerned with questions of technique, the reasons why co-catalysts are required in some systems but not in others, the effect of the dielectric constant of the medium and the relation between cationic polymerization and conventional Friedel–Crafts reactions. Prof. Dainton gave a final summing-up of the conference. The full proceedings of the conference will be published in book form. P. H. PLESCH

TRANSPARENT CONDUCTING FILMS ON GLASS

BÄDEKER in 1907[1] made some of the earliest observations on non-metallic films, obtained by suitable after-treatment of sputtered metal films. He observed that some, particularly certain oxide films, had appreciable electrical conductivity. After a comparative lull in interest, modern evaporation techniques provided a new stimulus for the study of non-metal films. Attention was then directed first to their optical properties. Rather later, research on semi-conductors and photocells aroused increasing interest in the electrical properties of the films. It is curious, perhaps, that not many investigators have hitherto studied both the optical and electrical properties and attempted to relate them to each other. Recently, however, the importance of their inter-relation has been emphasized by commercial applications in which both good transparency and the possibility of dissipating considerable electrical power in the films are prerequisites. The American so-called NESA film, used for electrically heated windscreens and windows, is a case in point.

In the Light Division of the National Physical Laboratory a study of this field started in 1947, in connexion with research on the selenium rectifier photocell. In this cell, the upper layer or film must of necessity be a fairly good conductor; but it must also be as transparent as possible if the sensitivity of the cell is not to be too much reduced by loss of light in transmission through it. In this study, Bädeker's experiments were repeated on a wider range of metals. His results—for example, on oxidized

cadmium films—were generally confirmed; but, in addition, unusual effects were noticed during the oxidation, by heating, of tin films on a glass substrate. A stage was reached, in certain cases, when the film had become transparent but shortly afterwards acquired appreciable electrical conductivity.

This observation is the basis of a new process proposed for the preparation of transparent conducting films. In it, a sputtered partially oxidized tin film on glass is subjected to suitable heat treatment. The initial film must be amorphous, it seems, while the final product after heating gives the electron reflexion pattern of stannic oxide. It is hard, adherent, and chemically as resistant as ordinary stannic oxide. Its optical transmission is in the region of 75 per cent. Resistance values of a thousand ohms, or rather less, between opposite edges of any square area, have been reached by this method, but still further reduction of this figure is expected as a result of work in progress.

The manufacture is as yet assured only on the laboratory scale. Application of the process to some commercial uses therefore awaits further development; but the present product is obviously suitable for a number of practical applications such as for anti-static windows in sensitive electrical instruments. It may also prove suitable for the manufacture of robust resistors, where the large surface area of the film should permit of an unusually large power-dissipation without undue rise in temperature.

Unlike the American process, the modified sputtering process used in making the tin oxide films is adaptable to a wide variety of substances, and other films now under study at the National Physical Laboratory show a great improvement on the American product in respect of electrical conductivity at a similar transparency. Some of their other properties remain still to be tested, and so it is too early as yet to forecast the precise field of application for these newer films.

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RESEARCH AND INVENTION IN THE UNITED STATES

REPORT OF THE NATIONAL SCIENCE FOUNDATION

THE establishment of the National Science Foundation in the United States by Act of Congress on May 10, 1950, broke new ground, comparable possibly with the establishment in Great Britain of the Advisory Council for Scientific and Industrial Research thirty-five years earlier. Some of the functions of the Foundation, however, are more in the field of those of the Advisory Council on Scientific Policy and the Defence Research Policy Committee set up in 1947. The Foundation, for example, is authorized and directed to develop a national policy for the promotion of basic research and education in the sciences; to support basic scientific research and to appraise the impact of research upon industrial development and the general welfare; and, at the request of the Secretary of Defence, to support specific defence research activities. Other functions, such as awarding scholarships and graduate fellowships in the sciences, fostering the exchange of scientific information, evaluating scientific research undertaken by Federal agencies, correlating the Foundation's research programmes with other such programmes and co-operating in international scientific research activities, follow the pattern of the activities of the Department of Scientific and Industrial Research or its Advisory Council in Britain; but the Foundation is also responsible for maintaining a register of scientific and technical personnel, and for serving as a clearing house for such personnel, a task which in Britain is in the hands of the Ministry of Labour and National Service.

The responsibility for disbursing Federal expenditure in this way is vested in a National Science Board of twenty-four persons eminent in science, medicine, engineering, agriculture, education and public affairs, appointed by the President of the United States and confirmed by the Senate; and the chief executive officer, the Director of the Foundation, is similarly appointed by the President and confirmed by the Senate. The first annual report of the Foundation*, covering the year 1950–51, is, as Dr. J. B. Conant, the first chairman of the National Science Board, emphasizes in a foreword, essentially a record of progress in formulating plans, and it will be several years before concrete achievements can be listed. Even in the field of applied science, research is in the nature of a long-term investment, while in the basic sciences there may be an even more considerable time-lag. Dr. Conant suggests, as a personal point of view, that it would be wise to discard the terms 'applied research' and 'fundamental research' and substitute 'programmatic research' and 'uncommitted research' as making clearer the difference between these two possible forms of research. A like suggestion has been made elsewhere, and Dr. Conant insists that in the United States it is the uncommitted investigator who is in the greatest need of public support, and that besides more financial support he requires wider public recognition. One purpose of the National Science Foundation is to assist the United States to produce its proper share of such scientific pioneers, and to secure that provision is made for the educational and research facilities which will assist the development of such men. Much of this first annual report is occupied by an able exposition of the nature of fundamental research and the importance of prosecuting it adequately, even in times of national emergency. Examples are cited from electronics, biology and medicine, including penicillin, to illustrate the need for sustained support. This part of the report, with its emphasis in conclusion on the dwindling time-lag, seems admirably argued to counteract the lack of knowledge which must have been responsible for the sudden slashing of the Foundation's appropriation early last autumn.

The immediate problem before the Foundation is, in fact, the relation of the present emergency to the support of basic research. The Foundation is planning its programme from the point of view that, since the degree and duration of the present emergency are uncertain, the United States must, with all dispatch, put itself into "operational readiness" and take the necessary steps to maintain itself in this state of readiness for an extended period, perhaps for many years. For science, this means that urgent military uses of science would be expedited where such uses could be put into practice in a short time, such as two or three years. This would involve careful selection

* First Annual Report of the National Science Foundation, 1950–51. Pp. ix+31. (Washington, D.C.: Government Printing Office, 1952.) 20 cents.

from the point of view of feasibility and of high priority. It equally involves the United States remaining in scientific readiness over a long period of years, with the utmost effort to strengthen its scientific progress and maintain that strength at the highest possible level.

It is at this point that the programme of basic research to be supported by the National Science Foundation can be most effective, and the report then details the questions to be answered in developing and formulating a national science policy. Much of this ground has been covered in recent years by the Steelman report, "Science and Public Policy", and the earlier Vannevar Bush report, "Science—the Endless Frontier". Among its first tasks the National Science Foundation plans to make a thorough review of the present national pattern of research and development. It will seek current answers to such questions as what is the total financial support now being provided for scientific research and its distribution among government projects, industry and educational institutions: what financial support can and should be provided, and what is the most desirable distribution. It will also be necessary to determine the division of research effort among the various natural sciences, and also the areas which need greater or less emphasis.

Estimates quoted in the report indicate that the United States is at present spending about 2,500 million dollars a year on research and development, of which 60–70 per cent comes from the Federal Government and 5 per cent from the universities. While industry supplies between 25 and 35 per cent of the funds, nearly two-thirds of the expenditure goes into industrial laboratories and facilities, slightly more than 10 per cent being in the universities. About one-fifth of the university research effort is in physics, and nearly one-half in the three areas of chemistry, physics and electronics. Another 25 per cent of the defence research work is in aeronautical and electrical engineering, mathematics and the terrestrial sciences. Continued pressure upon the universities for defence research without compensating support for basic research could, in the opinion of the Engineering College Research Council, which has examined the situation, easily upset the present balance.

The Foundation proposes to support basic research upon as broad a geographical and institutional basis as possible, as well as to examine the effect of Federal research programmes on the financial stability of universities. It is giving attention to the need for accurate current information on scientific man-power both for sound planning and for mobilization purposes. At present, it is estimated that about 130,000 engineers and scientific men in the United States are engaged in research and development, about 55 per cent being in industrial laboratories, 25 per cent in universities and non-profit-making institutions and the remaining 20 per cent in Federal and State institutions. The military research budget alone requires the services of 54,000 research scientists and engineers, or 47 per cent of the total in the United States. The projected plans for 1952 of the Defense Department, the Atomic Energy Commission and the National Advisory Committee for Aeronautics may take up to 70 per cent of the research man-power.

Such a position emphasizes the importance of the training programme in science which the National Science Foundation proposes to plan, as well as the necessity of securing the wisest and most effective use of the available supply of trained personnel. It is apparent that the Foundation is being led to engage on numerous activities which in Great Britain have for some time come within the purview of the Lord President of the Council or the Advisory Council on Scientific Policy, including the question of the dissemination of scientific information by existing means or by new techniques. Its future reports should be useful as well as interesting to those in other countries who have to confront similar problems, and may well contribute something to that mutual understanding and to the formulation of a common policy in matters of mutual interest for which Dr. Conant pleaded so eloquently and cogently during his recent visit to London. Meanwhile, this first report seems well fitted for winning fuller support in the United States, both from the general public and from scientific workers themselves, for a larger measure of central government endowment of research.

CENTIMETRE-WAVE RADIO LINKS

AT a meeting of the Radio Section of the Institution of Electrical Engineers on April 9, three papers were presented describing the theory, design and development of radio links which are now in general use for multi-channel telephony and television. The work described was carried out by a large group of engineers in the Telecommunication Laboratories of Standard Telephones and Cables, Ltd.

The first paper, by Dr. A. T. Starr and T. H. Walker, entitled "Microwave Radio Links", dealt with the general theory and design of such links as transmission systems. Following provisional allocation made at an international convention, the frequencies selected for study and development are about 4,000 Mc./s. (wave-length 7·5 cm.) for fixed links, and 5,000–6,000 Mc./s. (5–6 cm.) for mobile radio links. The paper deals with questions of propagation and atmospheric phenomena in so far as they affect the design, and with the conditions it is necessary to meet in order to reduce thermal and intermodulation noise to a minimum. The special problems of a television link are discussed.

The second paper, on "Circuit Technique in Frequency-modulated Microwave Links", by H. Grayson, T. S. McLeod and R. A. G. Dunkley, describes in more detail the circuit problems involved in wide-band communication links, and the principles of design of the amplifying, modulating and demodulating circuits involved. Special attention is given to the need for automatic frequency-control throughout the system. In the third paper, entitled "Microwave Techniques for Communication Links", G. King, L. Lewin, J. Lipinski and J. B. Setchfield describe theoretical and practical work involved in the development of radio links to work in the frequency range 3,600–4,200 Mc./s. (7·15–8·33 cm.). Special attention has been given to the problem of matching components of the system over the broad frequency band used, and this included the matching of waveguide sections as well as the feeding arrangements to the parabolic mirror type of antenna system used in this work. This paper contains a section on the measuring technique involved, with a description of a precision signal-generator developed for use at the frequencies mentioned.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Geometrical Representation of Thermal Transitions of Higher Order

As is well known, geometrical interpretations of Λ-type thermal transitions have been proposed on the assumption that, in a transition of the first order, the $G = f(p,V,T)$ surfaces intersect at a finite angle; for transitions of the second and higher orders, the $G = f(p,V,T)$ surfaces make contact. Contacts of the first order, second order, etc., are held to correspond with thermal transitions of the second order, third order, etc.[1]. Although this interpretation permits a formal representation of Λ-type transitions in terms of geometrical relationships between the free-energy functions G_1 above and G_2 below the transition point, it is not easy to correlate with structural changes accompanying these transitions.

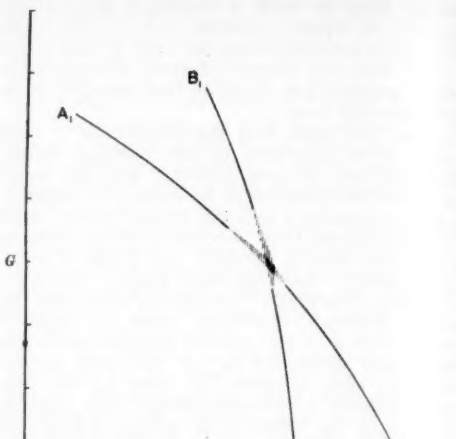
It is now suggested that, in reality, instead of making true geometrical intersection or contact at the transition point, the free-energy surfaces may exhibit an 'indeterminacy thickening' in the transition region. On this basis, it is not necessary to assume that the surfaces G_1 and G_2 make true contact at a transition point to explain Λ-phenomena. When the indeterminacy thickening is appreciable, even what would be an intersection with true surfaces becomes a region of overlap, which in many ways could simulate geometrical contact between infinitely thin surfaces.

The origin of this indeterminacy thickening can, in principle, vary according to the atomic framework of the system under investigation. In transitions in crystals which are accompanied by a volume change, the lattice can incorporate a certain amount of strain-energy by juxtaposition of regions which have, and have not, undergone the transition. To describe the local free energy of the crystal completely, it is necessary to introduce a local variable strain parameter π [2,3]. The function $G = (p,V,T,\pi)$ can assume a narrow range of values according to the values of π the crystal can withstand without breaking. Provided the relaxation time of the strain is large compared with the time of an experiment, this leads to a thickening of the free-energy surface, which is illustrated in section in the accompanying graph, where, of course, the difference of slopes is exaggerated to avoid excessive blurring of the overlap region in printing. Generally, a variable strain parameter will raise G_1 considerably and can scarcely lower it, so that the thickening from this cause almost lies wholly to one side of the limiting G curve. π can also be an order parameter expressing the degree of positional order of the atoms on the lattice sites, or in orientational transitions it may represent the coherence of orientation of the molecules on various lattice sites. When the thickening arising from a range of possible values of π with large relaxation time is appreciable, the phase rule is modified from the classical form:

$$F = C - P + 2,$$

to

$$F = C - P + 2 + \Sigma\pi,$$



where $\Sigma\pi$ represents the number of independent 'structural' contributions to the free energy[2], such as state of lattice strain, positional order in solid solutions, or orientational order in transitions which involve randomization of molecular orientation in the crystal.

An extension of this indeterminacy interpretation of 'contact' between free-energy curves may be suggested in the much-studied Λ-phenomena which accompanies the 'transition' from helium I to helium II. In the case of a liquid with freely mobile molecules, it does not seem likely that the free energy can include a strain or order parameter, which can assume a small range of values near the transition to another state. But in view of the low temperature and high zero-point energy, it is possible that the G_1 and G_2 curves for helium I and helium II show a quantum indeterminacy thickening, and consequent overlap, near the transition where another phase has practically the same free energy. The effect of this overlap would be geometrically similar to overlap effects accompanying structural transitions in solids; but the Λ-phenomena in the two cases would have a very different origin.

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A Possible Genetic Explanation and Understanding of Migration of Continuous Brooded Insects

The observations of D. and E. Lack[1] on a southerly migration of insects in October 1950 at Port de Gavarnie in the Pyrenees, which has since been confirmed in October 1951 by Messrs. D. W. Snow and K. F. A. Ross[2] and others, makes possible a hypothetical interpretation of migration on a genetic

basis for the first time. They observed between a hundred and five hundred butterflies per hour (*Colias croceus*, *Vanessa atalanta* and *Pontia daplidice*), one thousand to five thousand dragonflies (*Sympetrium striolatium striolatium*), and the syrphid fly (*Epistryphus balteatus*), "at least twenty times and perhaps one hundred times as common as the dragonflies" flying in a southerly direction. Dr. C. B. Williams[3] has for many years shown a southerly migration in *Vanessa atalanta* and more recently in *C. croceus* in Great Britain in the autumn, and the southerly migration of *D. plexippus* is a well-known fact in North America.

No cause for the stimulus to migrate has, however, been suggested other than direct environmental conditions such as heat, drought, overcrowding, or the "biological urge theory" of Heape[4], etc. This cannot be the sole mechanism, if only for the two following reasons: (1) there are always individuals left behind which do not migrate; (2) subsequent generations from the initial migrants, though bred in an entirely different environment, continue to migrate. It is the fact that this hypothesis may fit in with work already done on pupal diapause[5] which prompts me to publish it.

In 1947, I suggested[6] a possible theory of migration in insects on the following lines. In its simplest form there may be a gene for increased metabolic rate giving the individual a capacity for increased activity and migration (*M*), those individuals without it being *m*; the composition in the breeding area of, for example, *C. croceus*, at the beginning of the year would be *MM*, *Mm* and *mm*. *MM* individuals would be 'essential migrators', those with a constitution *mm* would be physiologically incapable of migration (possibly due to absence of fat body), and *Mm*, the heterozygotes, would be at a greater advantage than either homozygote in being able to migrate or not according to the exact environmental conditions. In years when conditions were disadvantageous, all the heterozygotes (*Mm*) would migrate, but in other seasons when not so affected would remain non-migratory. In a 'migratory year', succeeding generations passing north would inevitably increase their proportion of *M*, *m*'s being left behind, while conditions of decreased heat and absence of drought would tend to hold back a proportion of the heterozygotes, *Mm*. Assuming that the average life-cycle of *C. croceus* is about thirty-five days at mid-summer, several generations might take place between southern France and the Channel, by which time there must be a great increase in the proportion of essential migrators (*MM*). Towards the end of the summer, then, the gene frequency would show a cline from the north of England to the south of France with two homozygotes concentrated at opposing ends (*M* in the north and *m* in the south).

This suggestion was quite rightly criticized at the time on the grounds that there would be constant drainage of the gene *M* from its southern breeding grounds and that, as yet, there was insufficient evidence of a southern migration. In view of the recent observations, however, it would appear that there may be an autumn return of genotypes all along the cline towards their southerly breeding grounds, the more northerly returns containing a greater percentage of 'essential migrators' (*MM*) and finally meeting non-migrators (*mm*) who will have remained as such throughout the summer in reduced numbers. Between October and March at least one generation will take place in *C. croceus* (where there is no diapause), the heterozygotes of which would have no urge to migrate during the cooler months. It must be emphasized that this situation could only hold good so long as the heterozygotes held an advantage over both homozygotes for a majority of the time. This theory fits in with known facts: (1) that migration in vast numbers takes place in certain years only (*MM* and *Mm*); (2) that even in 'non-migratory' years certain individuals are seen migrating north (*MM*); (3) that there are always individuals which remain in the southern region no matter what the conditions (*mm*).

W. Hovanitz[7] has shown that in *Colias eurytheme* a single sex-limited autosomal gene (also controlling colour) is responsible for a change in activity. In the earlier part of the day (and to a lesser extent also in the latter part), this mutant flew in a greater proportion than did the typical. The idea of a genetic control of activity in the Lepidoptera is therefore not altogether new. It is not inappropriate to reflect at this stage, therefore, on the control of the pupal period in continuous brooded migrants by possibly the same gene conferring increased metabolism and activity in the adult. *Heliothis peltigera* is a well-known migrating species to Great Britain the pupæ of which have been shown (from wild larvæ collected in Britain) to fall into three categories in regard to habit and æstivation; essential æstivators, essential hatchers, and the majority, while capable of undertaking æstivation, nevertheless react according to the environment[8]. Jarvis[8] has shown a similar state of affairs in the pupæ of *Pieris brassicæ*. It is possible that the same gene which controls metabolism and migration might also control metabolism of pupal hatching and diapause. In this case the following situation would be found:

	Imago	Pupa
MM	Essential migrators; ? fat body present	Essential hatchers
Mm	Capable of migration or not; environmentally controlled	Capable of hatching or not; environmentally controlled
mm	Incapable of migration	Essential æstivators

Proof of this hypothesis, still unconfirmed, might lead to its application in the realm of pest-control in the following ways: (1) by attacking returning individuals outside their reservoir of breeding, thereby eliminating those homozygote to migration (*MM*); (2) by encouraging those individuals with the formula *mm* (non-migratory); great damage might, in fact, be done by elimination or reduction of these.

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Measurement of Osmotic Pressure in Single Cells

A cryoscopic method of measuring the osmotic pressures of very small quantities of fluid (10^{-6} c.c.) has recently been described by Ramsay[1]. The principle of the method is to place the liquid in a quartz capillary and freeze it by immersion in solid carbon dioxide. The system is then warmed and the temperature at which the smallest observable ice crystal remains in equilibrium with the liquid is noted. This constitutes the freezing-point depression. This method can be used for measuring the osmotic pressure of single cells and strips of muscle 50–200 μ in diameter, material of these dimensions being sufficiently transparent for the ice crystals to be clearly seen.

When the osmotic pressure of a muscle fibre is to be measured, the muscle is lightly blotted with filter-paper and teased to the required size under paraffin. It is then drawn up into a quartz tube 200–400 μ in diameter. Comparisons of the freezing-point depressions of blood and muscle of *Mytilus edulis* and of sea water are given in Table 1.

Table 1. Δ°C.

Exp. No.	1	2	3	4	5	6
Sea water	2·070	2·080	2·075	2·080	2·080	2·080
Blood	2·080	2·090	2·070	2·080	2·080	2·075
Muscle*	2·070	2·080	2·080	2·080	2·050	2·085

* Retractor byssus, equilibrated with blood.

In the case of single cells, the material is placed under paraffin in a watch glass. The amount of fluid around the cell should be minimal, any surplus being removed with a pipette. The freezing-point depression of the unfertilized eggs of *Psammechinus miliaris* was examined in this way, parallel determinations being made on sea water and eggs over a period of two hours, during which the sea water was allowed to become more concentrated by evaporation. The eggs remained fertilizable during this period. The results of the measurements are given in Table 2.

Table 2. Δ°C.

Unfertilized eggs of *Psammechinus miliaris*	Sea water (Millport)
1·79	1·79
1·82	—
1·87	1·86
1·90	1·92
1·91	1·90

The results in Table 2 are compatible with Lucké's[2] measurements of the permeability of the unfertilized eggs of *Arbacia punctulata*. Using Lucké's figure of 0·1 μ^3/μ^2/atm./hr., calculations show that the freezing point of the unfertilized eggs should be 0·005° C. lower than that of the sea water under the conditions of this experiment.

I am indebted to Dr. J. A. Ramsay for the use of his apparatus, to Lord Rothschild for providing the unfertilized sea urchin eggs, and to the Department of Scientific and Industrial Research for financial assistance.

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A Predacious Amœboid Organism destroying Larvæ of the Potato Root Eelworm and other Nematodes

While screening a number of chemicals for their nematicidal action on the cysts of the potato root eelworm, *Heterodera rostochiensis* Wollenweber, one of us (A. Ph. W.) discovered an amœboid organism which attacks the larvæ of this nematode. The organism was encountered in the form of brownish spherical, single-walled hypnocysts[1] 25–40 μ in diameter, firmly sticking to the surface of the cysts of *Heterodera*. If larvæ leave the cyst subsequent to treatment with an aqueous solution of potato root diffusate, or if larvæ suspended in tap water are added, creeping trophic forms emerge from the hypnocysts. The phenomenon can be best observed if the bottom of the container is not too smooth. Probably for this reason very good results were obtained in the small cavities drilled in clear plastic, in which the observations were carried out. Glass containers or slides and hanging-drop preparations were not so satisfactory.

The creeping trophic form consists of a thin body of colourless, uniformly granular protoplasm, branching and anastomosing, slowly and incessantly streaming, capable of division by plasmotomy, and of fusion with other individuals. Nuclei have not been observed. In tap water numerous minute contractile vacuoles are visible. The size of the trophic form ranges from 40 μ to 300 μ from end to end in the completely extended condition. Fig. 1 shows a creeping trophic form. Under less favourable conditions (on glass or in a hanging drop), a globular or irregularly angular trophic form emerges from the hypnocyst, furnished with numerous finely radiating pseudopodia.

The trophic form attacks the larvæ in the following manner. After adhering to a larva near its head or tail (Fig. 2), it engulfs the prey completely within a short time (20 min. to 2 hr.). The motionless larva is then seen lying in the protoplasm of the organism, which at this time is comparatively clear. Sometimes one or more other larvæ are caught in this sticky mass. The successful attack on three or even five larvæ simultaneously has been observed. After a time, a cyst wall is secreted and digestion starts. Initially, the form of the digestive cyst[2] is strongly dependent on the form of the prey (Fig. 3); but after one or two days the cyst becomes more globular. Some days later, no trace of the ingested larva(e) can be seen in the rather homogeneous protoplasm. In the centre a large excretion vacuole is developed. The protoplasm later detaches itself from the delicate cyst wall and creeps out as a large amœboid mass (diameter up to 300 μ), leaving the contents of the excretion vacuole behind.

If the supply of larvæ is exhausted, the protoplasmatic mass develops long rhizopodia, which can fuse with each other and with the rhizopodia of other individuals. Thus a freely branching network covering the whole bottom of the plastic container (diameter 5 mm.) may be formed. Neither distinct nuclear centres nor any differentiation of the protoplasm can be seen at this stage (at least as observed in unstained living specimens). Eventually, a concentration of protoplasm at the junctions of the rhizopodia takes place. The rhizopodia stretch and finally snap like taut strings at different places. In this way a number of creeping forms exactly like the form already described originate from the amœboid mass via the reticulate

(1) Two amœboid organisms, shortly after division. × 180

(2) Larva of *Heterodera rostochiensis*, the tail of which is attacked by the amœboid organism. × 180

(3) Same larva, engulfed by the organism. × 504, phase contrast photograph

stage. If prey is lacking, the young trophic forms soon encyst. When nematode larvæ are present, they are attacked immediately and new digestive cysts are formed.

Sometimes division does not occur, and the amœboid mass secretes a new cyst wall near the old empty one. It has been observed that the mass does not leave the cyst but divides inside it. This, in short, is vegetative reproduction as observed under laboratory conditions.

On some occasions sporocysts[1] measuring about 100 μ across have been observed. The contents of these sporocysts break up into numerous spores of 6–7 μ diameter with a central vesicular nucleus. One photograph of the spores suggests that the nuclei may divide by promitosis.

The hypnocysts can be stored for several months in tap water at room temperature. A temperature of more than 20–25° C. seems to hinder excystment, but at 2° C. the creeping forms are still active. It has not yet been established whether the nematode larvæ secrete substances which influence excystment.

Not only the larvæ of *Heterodera rostochiensis* but also other nematodes, namely, *Meloidogyne* sp. (= *Heterodera marioni*), *Ditylenchus dipsaci*, *Hemicycliophora* sp. and *Pratylenchus pratensis*, none of them exceeding 1 mm. in length, are attacked in the same manner. Attack on other organisms has not been observed. Cyanophyceæ, *Closterium*, *Spirogyra*, *Cladophora* with attached diatoms, *Azotobacter* and *Aerobacter* have been tried, but seem to be treated as indifferent objects.

So far, the organism has been found only on cysts of *Heterodera* at one place with sandy soil in the province of Groningen, Holland. Some material has been sent to Dr. B. N. Singh, of the Rothamsted Experimental Station, Harpenden.

The systematic position of the organism seems to be with the family Vampyrellidæ Doflein of the order Proteomyxa Lankester. No description has been found in the literature to fit the organism as regards morphology, life-cycle and feeding habits; indeed, the systematics of the group as a whole are inadequate, hence a new genus will probably have to be erected, even if only on a provisional basis.

Further research is being continued and will be directed to the study of the reproductive life-cycle, including nuclear division, geographical distribution and the behaviour of the organism in soil.

These investigations may be of value in showing whether this amœboid organism may eventually become an ally in the fight against the menace of the potato root eelworm and other nematode pests.

A more detailed account as well as a full description of this organism will be published elsewhere.

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Storage of Stilbamidine in the Animal Body

Earlier work[1–4] on stilbamidine (*trans*-4 : 4′-diamidinostilbene) had led to the conclusion that extensive retention and storage for prolonged periods must almost certainly occur after injection into the animal body; but the difficulties likely to be encountered in extracting the drug from body tissue, and estimating it, had rather deterred one from attempting to prove that prolonged storage does occur, and to determine the principal sites of storage. However, advantage has recently been taken of an

opportunity of working on this subject, and substantial progress has been made in solving the preliminary aspects of the problem of determining site or sites of storage, and the effect of such storage upon fat and mineral metabolism, in an attempt to explain the delayed toxic action of the drug and of the product of its photochemical dimerization.

A simple but somewhat tedious method by which adsorbed stilbamidine, total saponifiable and unsaponifiable fatty matter and mineral constituents can be determined on the same specimen, even a small one such as the spleen of a rat, within the limits of normal biological variations, has been elaborated. In the first place, liberation of adsorbed stilbamidine from organic tissue proved to be much easier than had been anticipated, the method finally employed, based on experience with the Reinsch test, consisting of digestion of the material on the water-bath for several hours with 10 per cent hydrochloric acid. The tissue readily disintegrates and the stilbamidine goes into solution. The undissolved matter, after filtration and washing, has been shown, by solution in cold concentrated sulphuric acid, to be free from stilbamidine. Stilbamidine added to similar material and similarly treated could be readily detected by the fluorescence of the concentrated solution or of a spot on filter paper after dilution of the acid to 25 per cent strength. The stilbamidine in the hydrochloric acid extract can readily be estimated roughly by comparison of the fluorescence of a spot of the solution on filter paper with that of a series of standard spots prepared from a similar medium. Total fatty matter is extracted from the hydrochloric acid filtrate and the undissolved residue by washing first with chloroform–petroleum ether, then chloroform, and can be examined in detail. All residues are then treated by Kjeldahl's method for inorganic constituents.

Certain important points have already been established. Even in the late stage of a course of injections, no detectable amount of stilbamidine was present in the blood plasma of a sheep, and none was present in the blood corpuscles. The liver of a sheep which died three months after the termination of a course of injections, presumably from the delayed toxic effects of the drug, contained a high proportion of stilbamidine. Most of the stilbamidine was isolated as the hydrochloride, using chromatographic adsorption on filter paper pulp, and its composition confirmed by micro-analysis, for which we are indebted to Dr. J. W. Cornforth, National Institute for Medical Research, London. There appears to be no tendency for hydrolysis of the amidine group to the amide group to occur in the body, which is an important point as the first hydrolysis product, 4-amido : 4′-amidino-stilbene, is more toxic than the parent compound[1,2]. Rats appear to be considerably more sensitive to the toxic action of the drug than are mice or guinea pigs. So far as the limited observations at present available show, stilbamidine is heavily adsorbed in the rat liver after injection; but, even when death ensues at a later stage, it has been largely eliminated from the liver before death occurs. In this respect the rat seems to differ radically from the sheep.

In the case of a rabbit which had received a course of injections and was killed two months later, no organ, even the skin, was entirely free from stilbamidine. This wide distribution in the body may be of special significance.

Extensive further work on this subject in order to eliminate the effect of the wide variations within a species, and even more the wide differences in reaction of different species, is clearly necessary. Still more work will be necessary in order to determine whether or not storage of stilbamidine produces any pronounced interference with fat or mineral metabolism, which might well explain the delayed toxic action of the drug. Unfortunately, we are unable to expand this work on the necessary scale in the near future, so the present results are given here.

We are indebted to Dr. R. Kirk and the staff of the Stack Medical Research Laboratories for facilities placed at our disposal, and for much assistance in this work.

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Ascorbic Acid Levels in the Plasma of some Antarctic Birds and Mammals

During the course of the 1950–51 Australian National Antarctic Research Expedition to Macquarie Island, a study was made of the levels of ascorbic acid in the plasma of members of the expedition. At the same time, the opportunity was taken of determining the ascorbic acid levels in the plasma of a number of birds and mammals from the Island.

The 2 : 6 dichlorophenol indophenol method used by Farmer and Abt[1] as described and slightly modified by Pecover[2] was used. The accompanying table gives the results of the observations. Using this method, it can be seen that the birds, with the exception of the Macquarie Island cormorant, have approximately twice the ascorbic acid of the mammals (including man). In this respect they are similar to hens 2·05 (1·46–2·43) as determined by Satterfield *et al.*[3]. Other reported values which may be compared with those in the table are: rabbit, 0·041 mgm./100 ml. (Munsell *et al.*[4]); sheep, 0·56 (Rasmussen *et al.*[5]); and pre-school children from Canberra, 0·80 (Pecover *et al.*[6]).

Ascorbic Acid Levels in Plasma of some Antarctic Birds and Animals

Name	No. of observations	Mean plasma ascorbic acid (mgm./100 ml.)	Standard deviation
Nelly (giant petrel), *Macronectes giganteus*	10	1·72	0·179
Skua (southern skua), *Catharacta skua lonnbergi*	8	1·20	0·241
Dominican gull, *Larus dominicanus*	4	1·76	0·115
Gentoo penguin, *Pygoscelis papua*	2	1·58	0·06
Rockhopper penguin, *Eudyptes crestatus*	3	1·31	0·279
Cormorant (Macquarie Island), *Phalacrocorax albiventer purpuracens*	2	0·76	0·170
Weka, *Gallirallus australis*	1	1·39	—
Sea elephant, *Macrorhinus proboscideus*	6	0·66	0·137
Rabbit (Macquarie), *Oryctolagus cuniculus*	2	0·99	0·120
Sheep, *Ovis aries*	4	0·63	0·236
Man, *Homo sapiens* (White Australian)	7	0·70	0·162

Although the primates and the guinea pig are the only warm-blooded creatures (so far as is known) which cannot synthesize their own requirements of ascorbic acid, it is probable that in many other animals and birds the diet contributes to the ascorbic acid found in the body tissues.

Ascorbic acid is an indispensable hydrogen carrier in the metabolism of animals. It is known that the metabolism of mature birds of different species varies more nearly with the 0·66 power of body weight than the 0·73 power as appears to be the case with mammals[7]. It seems probable that the higher plasma ascorbic acid level of birds is related to the higher metabolism of avian tissues compared with those of mammals.

E. H. Hipsley, medical officer-in-charge of the Australian Institute of Anatomy, Canberra, gave advice and assistance with this study.

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Symbiosis and Phylogenesis in the Isoptera

SOME years ago—in 1924—I discovered bacteriocytes in the fat tissue of an Australian termite, *Mastotermes darwiniensis*, and I fully realized the phylogenetic significance of this discovery. My interpretation was confirmed by the researches of Kock, a pupil of Buchner.

I asserted, quite emphatically, that *Mastotermes* alone among termites demonstrate the bacterial symbiosis which every cockroach presents. I had not found bacteriocytes in *Reticulitermes lucifugus* (Rhinotermitidæ), *Calotermes flavicollis* (Kalotermitidæ), or *Termopsis* (Hodotermitidæ); but I had no opportunity of studying *Archotermopsis*, and I could only assume the absence of bacteriocytes from the fact that Imms, studying *A. wroughtoni*, observed nothing of the kind.

I am now able to state that, from a recent examination of specimens of *A. wroughtoni*, some of which have kindly been given me by Emerson (Chicago), that this archaic species of termite has neither bacteriocytes like *Mastotermes* nor any feature—for example, bacteria scattered through the fat tissue—that could represent rudiments of an ancient symbiosis.

Considering all the evidence, I feel that the order Isoptera should be divided into two suborders: Mastotermitidæ and Termitidæ, the first with one family, one genus and one living species only.

The primitive characters of *M. darwiniensis* prove the archaicness of the suborder; such specialized characters as it has—like the complications of nest-building capacities and of social life—show the extent of its evolution since the Eocene (at least).

Perhaps further study of the hypermastigin symbionts would give other evidence to show whether Mastotermitidæ should be separated from all the other Isoptera or not.

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Dec. 10.

New Vectors of Strawberry Viruses

FRAZIER[1] has reported recently that certain strawberry viruses in California are transmissible by five species of aphids in addition to the long-established vector, and common strawberry aphid, *Pentatrichopus* (*Capitophorus*) *fragæfolii* (Ckll.)[2]. In Britain only *P. fragæfolii* and the closely related *P. tetrarhodus* Walk. were shown[3] to transmit crinkle, and only the former is known to transmit yellow-edge[4].

Experiments at East Malling showed, in 1950, that the aphids *Myzus ascalonicus* Doncaster and *Acyrthosiphon malvæ* subsp. *rogersii* (Theob.) could transmit two components of the strawberry virus complex, and this was confirmed in 1951. *Aulacorthum solani* (Kltb.) failed to transmit any of the viruses. The relevant details of some of the tests are given in the accompanying table.

The aphids were allowed long feeding periods of several days on plants infected with both mild crinkle (short persistence), crinkle and yellow-edge (long persistence) viruses. Long test-feeding periods on *F. vesca* plants were also used, so that the aphids would have conditions known to be suitable for a high rate of virus transmission by *P. fragæfolii*[5]. The

RESULTS OF SOME TESTS WITH STRAWBERRY VIRUSES AND SPECIES OF APHID

Aphid species*	Virus source	Infection feed (days)	Test feed (days)	Aphids per plant	Test plants	
					Infected	Symptoms
Acyrthosiphon malvæ subsp. *rogersii*	yellow-edge and crinkle	4	7	5	1/5	vein-clearing,
		10	9	10	5/10	crinkle, vein-clearing
	crinkle	9	10	10	2/5	crinkle
		2	7	10	1/5	crinkle
	mild crinkle	2	3	10	2/2	vein-clearing
		10	10	20	1/3	mild crinkle
	vein-clearing	5	1	10	1/3	vein-clearing
Aulacorthum solani	yellow-edge and crinkle	2	5	10	0/5	—
		3	7	10	0/8	—
		4	6	50	0/3	—
	yellow-edge and crinkle	3	4	10	1/5	vein clearing
		4	1	10	0/5	—
	vein-clearing	2	1	5	1/10	vein-clearing
Myzus ascalonicus	crinkle	5	8	10	3/8	vein-clearing
		5	8	10	0/5	—
		2	8	10	1/5	crinkle

* Provided and determined by Dr. G. H. L. Dicker.

viruses transmitted were tested by serial transfers and found not to persist for more than three hours in the vector. It appears that only viruses with short persistence are transmitted by *A. malvæ* and *M. ascalonicus*, both of which are less efficient vectors than *P. fragæfolii*.

Two types of symptoms developed on the test plants. One was the common mild crinkle type and the other was vein-clearing. This vein-clearing symptom has seldom occurred in experiments with *P. fragæfolii*; whether it is due to a distinct virus or to a strain of the mild crinkle virus is still uncertain.

The three species of aphids tested here were not included in Frazier's experiments, so that the strawberry viruses of short persistence in the vectors are now known to be transmissible by nine species of aphids: *Macrosiphon pelargonii* Kalt., *Acyrthosiphon malvæ* subsp. *rogersii* (Theob.), *Pentatrichopus fragæfolii* (Ckll.), *P. tetrarhodus* (Walk.), *Amphorophora rubi* (Kalt.), *Myzaphis rosarum* Walk., *Myzus ascalonicus* Doncaster, *M. ornatus* Laing and *M. porosus* Sand.

The importance of species other than *P. fragæfolii* in the spread of strawberry virus diseases has yet to be determined. Although some of the alternative vectors rarely breed on strawberry, and others, such as *A. malvæ* and *M. ascalonicus*, are inefficient vectors, they may be important as introducers of virus from extraneous sources into virus-free fields.

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Dec. 3.

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Inhibition of Photosynthesis by Cyanide

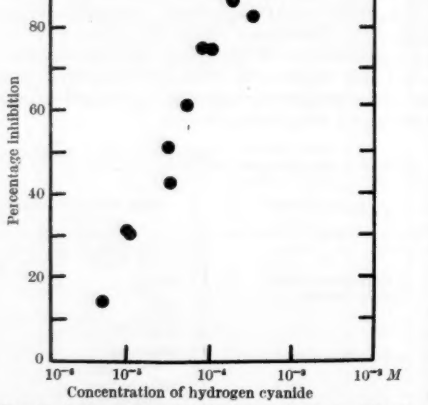
In some organisms, for example, *Chlorella*, photosynthesis at high intensity of light and high concentrations of carbon dioxide is inhibited almost completely by concentrations of cyanide which do not inhibit the endogenous respiration[1]. The inhibition is smaller at lower light intensities[1,2]. Therefore, it has been suggested that cyanide inhibits a dark process in photosynthesis, such as the dark fixation of carbon dioxide which has been shown to be strongly inhibited by cyanide[3]. The possibility remains that the fixation of carbon dioxide is not the only cyanide-sensitive reaction in photosynthesis.

The relationship between concentration of carbon dioxide and percentage inhibition by cyanide of photosynthesis at 'saturating' intensities of illumination was investigated with *Chlorella pyrenoidosa* grown for four days in 4 per cent carbon dioxide in air and then for one day in air. (This treatment results in a rate of photosynthesis in bicarbonate–carbonate buffer solutions which drifts little with time both in the presence and absence of cyanide[4].) Rates of photosynthesis were determined manometrically with cells in acid phosphate with 4 per cent carbon dioxide, in bicarbonate, and in bicarbonate–carbonate solutions. The practicable range of concentrations of bicarbonate is limited by rapid exhaustion of carbon dioxide in dilute solutions and by a depressant effect observed with high concentrations. With cells in bicarbonate solution and in bicarbonate–carbonate buffer the inhibition by cyanide of photosynthesis at the same concentration of carbon dioxide but for different hydrogen ion concentrations was the same only when the concentration of undissociated hydrocyanic acid was equal. Thus, for photosynthesis, just as for cytochrome oxidase[5], the cyanide ion has little effect, inhibition being due entirely to the undissociated molecule. Since at *equilibrium* the concentration of hydrocyanic acid inside the cell must equal that in the external solution, the inhibition of photosynthesis will depend only on the external concentration of hydrocyanic acid and will be independent of the *p*H within the cell. The percentage depression due to $3{\cdot}8 \times 10^{-5}$ *M* undissociated hydrocyanic acid is greatest at low concentrations of carbon dioxide, approaching zero for the highest concentration (Table 1). With concentrations of carbon dioxide higher than that used, a complication arises since the rate of photosynthesis is depressed in the absence of cyanide and presumably, although possibly to a smaller degree, in the presence of cyanide. Since the inhibition due to cyanide is almost completely removed at high concentrations of carbon dioxide, the simplest interpretation is that the predominant effect of cyanide is on that part of the system concerned with the fixation of carbon dioxide.

Table 1. Percentage Inhibition of Photosynthesis of *Chlorella* by Cyanide
(Concentration of free hydrocyanic acid (HCN), $3{\cdot}8 \times 10^{-5}$ *M*)

Concentration of carbon dioxide (*M*)	$1{\cdot}79 \times 10^{-3}$	$78{\cdot}7 \times 10^{-4}$	$9{\cdot}8 \times 10^{-4}$		$0{\cdot}90 \times 10^{-4}$
*p*H	4·6	9·4	8·3	10·0·8	8·3	10·6
Percentage inhibition	7·2	49·0	48·0	54·4	53·7	82·5

The effect of different concentrations of cyanide on photosynthesis with a 'saturating' light intensity and carbon dioxide concentration ($78{\cdot}7 \times 10^{-4}$ *M*) is shown in the accompanying graph. Contrary to the earlier claims of Warburg (although not contrary to



Inhibition by hydrocyanic acid of photosynthesis in *Chlorella*. Abscissa: Concentration of undissociated hydrocyanic acid (logarithmic scale). Ordinate: The difference between the rate of photosynthesis in the absence of cyanide and that in its presence as a percentage of the uninhibited rate. Light intensity, 35,000 lux. Carbon dioxide concentration, $78{\cdot}7 \times 10^{-4}$ *M*; *p*H 9·36; temperature, 25° C.

Table 2. Inhibition of Photosynthesis by Cyanide Below the Compensation Point

Concentration of hydrocyanic acid (mol./l.)	Rate of respiration	Rate of apparent assimilation
0	1·5	21·7
$1·9\times10^{-3}$	1·5	− 0·19
$2·7\times10^{-3}$	1·0	− 0·51
0	1·4	20·6
$1·9\times10^{-3}$	1·2	0·0
$4·4\times10^{-3}$	0·6	− 0·52

the results quoted by him), high concentrations of hydrocyanic acid inhibit photosynthesis below the compensation point (Table 2). Hence, we need not suppose, as Warburg suggested, that the products of respiration differ from carbon dioxide in being photosynthesized by reactions which are not sensitive to cyanide.

I am grateful to Prof. G. E. Briggs for discussion and to the Agricultural Research Council for financial support during the course of this work.

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Cancerous Response in Plants

The cancerous response of bacteria-free crown-gall tissue has been established by continued proliferation free from the causal organism or external source of auxin, and by experimental implanting. However, the action of an implant on a healthy host has remained in question, since the implant might effect a cancerous response[1], no response[2], or a temporary stimulatory response[1,3].

Bacteria-free tumour tissue obtained from primary galls of *Helianthus annuus* and cultured on White's media[4] was implanted in healthy stem segments isolated from *Helianthus* seedlings. The double slant technique of de Ropp[5] was not found necessary. From two to seven weeks later, the growing tumour implant was removed easily and the host tissue retained for subsequent growth. In all cases where the implant had died, the hosts were likewise retained. Control stem segments were left free of tumour tissue or else grafted with healthy stem segments.

The tumour implant, which continued to grow in the same manner as it had on nutrient agar, could be distinguished from the host by its characteristic nodular texture and fawn colour. It was removed easily from the host callus because of sparse areas of weak fusion. The host stocks which supported such implants exhibited varying degrees of a stimulatory response beyond that of control stems: the production of abnormally swollen roots, of abnormal basal callus and apical callus, and of overall cortical proliferation. This response was similar to that of sunflower tissue exposed to high concentrations of auxin[6]. However, on continued culture after removal of the implant, the host stocks showed an earlier necrosis than controls, and no further proliferation.

In cases where the implant died after about two days, the host exhibited a limited stimulatory response and a delayed necrosis comparable with that of control stems and stems treated with low concentrations of growth hormones[7]. However, 5 per cent of the stems bearing dead implants produced a tumorous protuberance which arose from the apical callus of the host two weeks after implanting. At first, these protuberances were greenish-white, smooth-surfaced spheres resembling the host callus, but they rapidly grew into large tumours which showed the cream colour and nodular growth habit of bacteria-free crown-gall tumour tissue. Further growth behaviour of this new tumour tissue was identical with that of autonomous crown-gall tumour tissue.

As evidenced by the above, the action of a growing tumour implant on a healthy host effects a temporary stimulatory response which does not continue in the absence of the implant and which hastens necrosis. In view of the parallel stimulatory response of healthy tissue to high concentrations of auxin, as well as direct[8] and indirect evidence[7,9–11] of the production of auxin by bacteria-free tumour tissue, this response could be explained on the basis of the auxin supplied by the tumour implant. However, in certain cases where the implant was short-lived, the host afterwards produced a tumour which exhibited all the characteristics of autonomous crown-gall tumour tissue. The experimental production of tumours from healthy tissue by supply of auxin[10] has only brought about a response intermediate between that of normal and crown-gall tumour tissue. However, the change of healthy into tumour tissue observed here through response to a short-lived implant has been positive in nature. Various substances, including auxin, diffusing from the implant during its brief survival, may bring about the production of such new tumour tissue.

In connexion with this investigation, I wish to express my thanks to Dr. D. A. McLarty for helpful advice, and to the Cancer Institute of Canada for financial assistance.

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Local Hydrological Conditions in Lake Victoria

Some preliminary work on the hydrological features of Lake Victoria was carried out in 1928 and 1931[1–3]. The general conclusion was that due to frequent mixing of the surface and bottom waters, stratification in the Lake is only temporary and deoxygenation of the water never occurs. It has been found, however, that stratification and deoxygenation of the bottom

water does occur in certain coastal areas, and is brought about by a process not previously described.

The observations recorded here were collected from the Buvuma Channel, an area of thirty square miles which lies at the north end of Lake Victoria between the mainland and the line of islands which separates it from the Lake proper. This channel is about twenty metres deep, whereas beyond the islands the Lake is sixty metres deep.

During November 1950–April 1951 the water in the channel was thoroughly mixed and at a temperature around 26° C., with oxygen values around 7 p.p.m. throughout. During this period, the temperature gradient over the whole twenty metres was never more than 0·3° C.; the temperature of the bottom deposits was slightly below that of the overlying water.

From the beginning of May onwards, the water started to cool by stages, the bottom water first; then subsequent mixing caused cooling of the whole water column (see graph). The values for dissolved oxygen in the water remained high from surface to bottom despite the brief thermal stratification induced in May by the sudden appearance of cooler water at the bottom. In June the temperature of the bottom water fell again, this time, however, to a value below that of the bottom deposits, and there was an immediate and significant drop in the dissolved oxygen content of the bottom water. Rough weather caused mixing and the oxygen values were restored. In July the temperature of the bottom water dropped considerably below that of the mud, and almost complete deoxygenation of the bottom water was observed. Rough weather during July 16–25 caused complete mixing and re-established uniformly oxygenated conditions, but at the expense of the previously high values obtained in the upper waters. As soon as calm conditions prevailed, the channel waters became stratified and the deoxygenation of the bottom waters proceeded rapidly and was almost complete by the end of August. These conditions, with minor fluctuations, were maintained until mid-November.

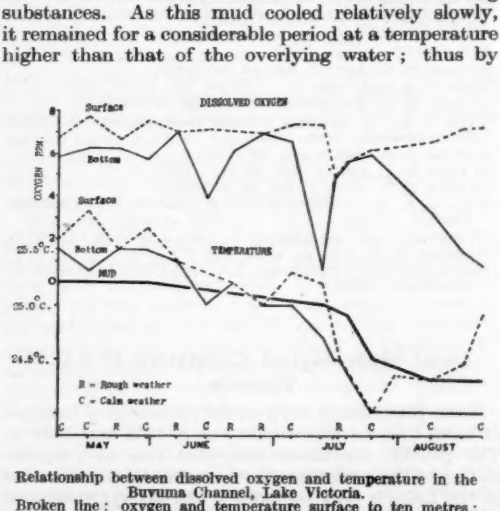
The mud from the channel was shown by chemical and electrical measurements to contain reducing substances. As this mud cooled relatively slowly, it remained for a considerable period at a temperature higher than that of the overlying water; thus by convection the rate of exchange of these reducing substances between mud and water was greatly increased. This was shown not only by the rapid rate at which the bottom water became deoxygenated but also by the increase in the oxygen demand of this water. On May 23 the oxygen demand was 0·6 mgm./l., whereas on August 8 it was 3·2 mgm./l. The plankton population during this period remained at a low level and could not have caused this change in oxygen demand.

The way the temperature of the bottom water falls independently of that of the surface water can only be brought about by the intrusion of colder water from the main lake. It can be seen from the accompanying graphs that this occurred at approximately monthly intervals within the following periods: May 9–16, June 6–13 and July 5–16. The observations, together with others not within the period under discussion, suggest the occurrence of a temperature seiche in the main lake.

Existing facilities and the great size of Lake Victoria have so far made it impossible to carry out investigations in the open water; but before long it is hoped to determine directly the water movements in the main lake.

Similar events to those described above were observed in the previous year, but in less detail; towards the end of the year, when the water was again completely mixed, a large increase in the phytoplankton population was observed. Thus in these coastal areas, considerable annual variations occur in the chemical composition of the water, and in its fertility, although the annual change in temperature is less than 2·5° C.

It should be noted that the conditions of stratification and deoxygenation described in this communication occur during the cool season. In any lake considered as a whole, such conditions usually occur during the warm season; it seems likely, therefore, that Victoria should be considered as a lake containing within its compass water masses the annual hydrological cycle of which is the reverse of the annual cycle in the main lake.



Relationship between dissolved oxygen and temperature in the Buvuma Channel, Lake Victoria.
Broken line: oxygen and temperature surface to ten metres; continuous line: oxygen and temperature half a metre from bottom; heavy line: temperature of bottom deposits

My thanks are due to the Director of the East African Fisheries Research Organization and to other members of the staff for considerable help during the course of these investigations.

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Nov. 28.

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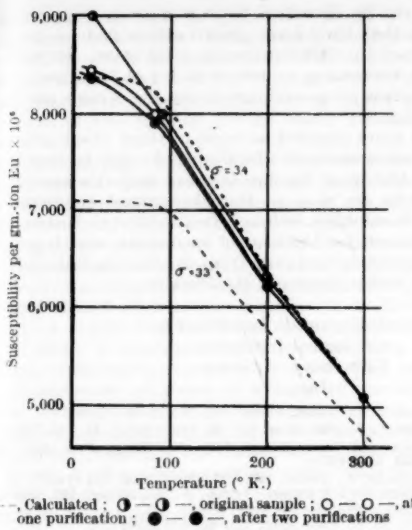
Magnetic Susceptibilities of Europium Sesquioxide and of Uranium Dioxide at Low Temperatures

For the ion Eu^{3+}, in which the multiplet intervals are not very great compared to kT, Van Vleck[1] gives theoretical magnetic susceptibilities which are almost independent of temperature below 80° K. The actual values depend on the screening constant, and extrapolation[2] from the known levels of Sm^{3+} suggests that the screening constant, σ, for the Eu^{3+} ion should be 33. If this is correct, then the theoretical susceptibilities are as represented in the accompanying graph. Susceptibilities calculated for $\sigma = 34$ are also shown.



- - - -, Calculated ; ◑ — ◑ —, original sample ; ○ — ○ —, after one purification ; ● — ● —, after two purifications

There appear to be no experimental data on europium compounds below 80° K. except for the brief report by Fritsch[3] to the effect that the susceptibility of the sulphate is the same at 20° K. as at 80° K. Above 80° K. the available data[4] seem to be in agreement with Van Vleck's theoretical values[5], although no definite decision regarding the screening constant is possible on this basis.

We have determined the susceptibility of spectrographically analysed samples of europium sesquioxide between the temperatures 20° K. and 300° K. This was done on a Faraday balance, the sample being suspended in helium from a sensitive silica spiral. All measurements were made at two or more field-strengths to exclude the possibility of ferromagnetic impurities.

The europium was part of a gift from the late Prof. Herbert N. McCoy. Spectrographic analysis, for which we are indebted to Dr. D. C. Stewart and his associates at the Argonne National Laboratory, revealed negligible proportions of paramagnetic impurities and, specifically, less than 0·1 per cent of gadolinium and less than 0·2 per cent of samarium. These two elements are the most probable paramagnetic impurities in europium. Apparent susceptibilities per gram-atom of Eu^{3+} corrected for diamagnetic components in this (original) sample are shown in the graph. Agreement with the Van Vleck theory is good down to 80° K., but poor at lower temperatures.

It will be clear that a trace of paramagnetic impurity following the Curie law might have a quite negligible effect on the apparent susceptibility of europium at room temperature, but could have a very great effect at temperatures approaching absolute zero. For this reason further purification was attempted. This was done by reduction and precipitation of the europium as sulphate, followed by reconversion to the sesquioxide. This purification diminished the low-temperature susceptibility. A further purification by the same procedure gave only a slight change in the susceptibility. It may therefore be concluded that the susceptibility of pure europium follows the Van Vleck theory fairly well down to 80° K., and that there is a moderate deviation in a positive direction at lower temperatures. The susceptibility results seem to favour $\sigma = 34$. It may be pointed out that at 20° K., and below, the magnetic criterion of purity for europium (III) compounds with respect to most paramagnetic impurities is considerably more sensitive than spectrographic methods. The susceptibilities of the purest sample, per gram of sesquioxide, are shown in the accompanying table. We believe that the preparation of the sesquioxide, involving strong ignition in air, precludes the possibility of divalent europium as an impurity.

MAGNETIC SUSCEPTIBILITIES (× 10^6) PER GM. OF EUROPIUM SESQUIOXIDE AND OF URANIUM DIOXIDE

Temp. ° K.	Eu_2O_3	UO_2
298	28·7	8·65
195	35·3	11·0
85	45·0	—
80	—	15·2
20	47·2	19·5

We have also measured the susceptibility of uranium dioxide. This substance was prepared by the method used by Trzebiatowski and Selwood[6]. The susceptibilities per gram of dioxide were found to be as shown in the table.

These results are slightly lower at 300° K. than those previously reported from this laboratory. The Weiss constant is 220°, which is the same as that given by earlier results.

The interesting feature of the new datum at 20° K. is that uranium dioxide shows no indication of a magnetic anomaly corresponding to an antiferromagnetic Curie point. The influence of exchange forces in the dioxide has been shown to be substantially less than in, say, chromium sesquioxide or in manganese dioxide, but nevertheless considerably stronger than in the rare earth sesquioxides. In view of the report[7] that uranium dioxide shows a specific heat anomaly with a maximum at 28·6° K., it is surprising that the plot of reciprocal susceptibility against temperature is a straight line over the interval studied, namely, 20° K. to 300° K.

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Spiral Growth Patterns on Apatite Crystals

RECENTLY, observations of the growth spirals suggested by Frank's theory[1] have been reported on crystals of beryl[2], *n*-paraffin[3], silicon carbide[4], cadmium iodide[5] and gold[6]; for mica[7] experimental evidence has been put forward to support the hypothesis that here, too, the same mechanism is responsible for the growth of the crystals.

We have now observed growth spirals originating from screw-dislocations on the prism faces ($10\bar{1}0$) of yellow fluor-apatite crystals. The observations were

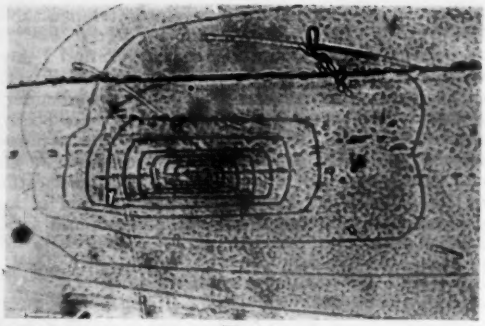

Fig. 1

made by means of an ordinary metallurgical microscope, using bright-field illumination. The photographs were taken slightly off focus. The surfaces were lightly silvered before examination. The height of steps was found by means of multiple-beam Fizeau fringes, measuring the deviation of the fringes caused by a known number of steps. We found for the step-height an average value of 10 ± 2 A., showing that the observed growth sheets are unimolecular, as in the case of beryl, and that the growth-promoting dislocations are of unit strength.

Although the density of dislocations is large, in a certain region, only a small number of them dominate the growth of the face. On one face, 35 mm.^{2} in surface, there were, for example, only two systems of dominating dislocations, both of double activity; one (Fig. 1) consisting of two spirals of equal sign, and one (Fig. 2) composed of two spirals of one sign and a third spiral of the opposite sign. The other dislocations only caused the breaking up of the growth fronts into complicated patterns.

The razor-blade shape of the growth spirals is very similar to those observed on beryl. The straight edges are parallel to the *c*-axis of the hexagonal crystal; the curved edges are parts of the same circle, centred approximately on the point of emergence of the screw-dislocation. This shows that the two-dimensional growth-rate has two sharp minima in a direction normal to the *c*-axis, while for an extended angular range of directions the growth velocity is practically independent of the orientation of the growth front. The unequal spacing of the straight edges shows that the two minima are not equivalent, as is the case for beryl. The polar diagram for the growth velocity has only a line of symmetry perpendicular to the *c*-axis.

The exact growth process of the crystals is not known for certain. The doubly terminated crystals had to be detached from a matrix, supporting the idea that they have grown either from a magmatic melt or by diffusion in the solid state. In each case it is interesting to note that for at least one of these complicated growth processes the Frank mechanism works.

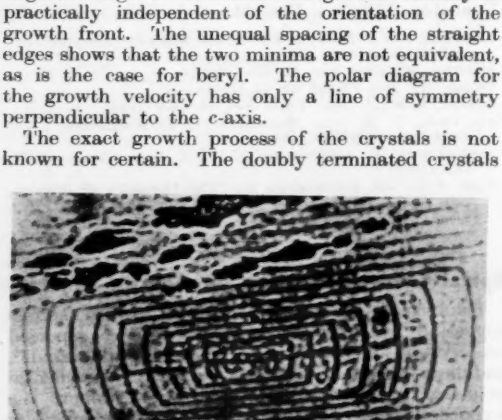

Fig. 2

A more detailed account of these observations will be communicated elsewhere. I wish to thank Prof. W. Dekeyser for his interest and discussions. My thanks are due to the Mineralogy Department of the Koninklijk Belgisch Instituut voor Natuurwetenschappen for the loan of specimens, and I gratefully acknowledge support from the Centre National Belge de Chimie-Physique Moléculaire.

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Delayed Fracture of Metals under Static Load

Delayed fracture under static load is best known in the case of glass, where it has been explained by Orowan[1] as arising from gas adsorption on the Griffith crack surface. A similar theory has been discussed by Gurney and Pearson[2].

If S_a and S_c are the energies of the adsorbed and clean surfaces respectively, E is Young's modulus and the glass contains a Griffith crack of width $2c$, which has adsorbed gas on its surface, the fracture stress under rapid loading will be given by the Griffith relationship $\sigma_c = (2ES_c/\pi c)^{1/2}$. S_c is involved because the new surface produced is clean. If adsorbed gas could cover the new surface as it formed, the fracture stress would be the lower value σ_a given by substituting S_a in the above relationship.

When the glass is loaded to a stress greater than σ_a, but less than σ_c, the crack will be unstable and will gradually extend at a rate controlled by the supply of gas for adsorption on the surface produced. This gradual extension will be replaced by sudden fracture when the crack has grown to such a size that the applied stress can propagate a clean surface. Thus, delayed fracture can occur. Under rapid loading, σ_c will be the fracture stress, but it can decrease to σ_a if the time-dependent crack-growth takes place; below σ_a there is no tendency for the crack to grow.

It seems possible that metals should show a similar effect, and we consider that the hydrogen-embrittlement of iron may be an example.

A widely held theory of hydrogen-embrittlement[3] supposes that it is due to the stresses created by the accumulation of molecular hydrogen in internal cavities, but objections can be raised to this theory. The most obvious alternative in keeping with the production of cleavage and intercrystalline fracture is simply that the brittle strength is lowered by the hydrogen uniformly distributed in solution; but the small quantity necessary suggests that some con-

centration mechanism is operative. Such a mechanism could be supplied by hydrogen adsorption on the Griffith crack surface, and if this occurred the fracture stress could then be reduced to σ_a as in the above discussion provided that the time-dependent extension of the Griffith cracks under stress takes place.

The interesting feature of this theory is its prediction that a time-delay is necessary for the development of the embrittlement. Because of the mobility of the hydrogen, the delay might be quite short.

The prediction has been examined experimentally. There is already some evidence that suggests the existence of a delay. Thus, hydrogen has little effect on Izod values ; a decrease in the amount of embrittlement in a tensile test has been observed[4] when the rate of strain is increased to 5–8 per min., and, since our own work began, there has been a further report[5] of a dependence upon rate of strain. In our experiments, hydrogenated iron was fractured (*a*) very rapidly by a falling weight, (*b*) in a tensile machine during a test taking a few minutes. Typical results are given in the accompanying table and, in confirmation of this aspect of the theory, they show that there is, in fact, a delay such that no embrittlement is detected at the rapid rate of loading.

Condition	Test	Reduction of area (per cent)
Hydrogen-charged	Tensile machine	27·0
Hydrogen-free	Tensile machine	61·5
Hydrogen-charged	Falling weight	60·5
Hydrogen-free	Falling weight	60·5

A distinction between the present case and that of glass is that the adsorption atoms can be supplied from solution. Thus, the extension of a crack under stress will take place in steps which occur when hydrogen solute atoms arrive at its edge in the course of diffusion, and the process will be helped by the fact that the hydrogen will actually be attracted into the stress concentration at the crack edge, in the manner that carbon atoms are attracted into a dislocation.

Since this theory of hydrogen embrittlement depends upon hydrogen adsorption on the new iron surfaces produced by extension of the original Griffith cracks, embrittlement is independent of the exact physical nature of the latter ; all that is necessary is that they should be some form of stress concentrator.

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Dec. 14.

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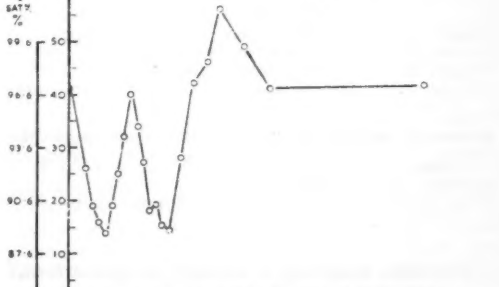
Effect of Critical Flicker Frequencies on oximetrically determined Arterial Blood Oxygen-Saturation Levels

Work in this clinical laboratory on some of the physiological epiphenomena accompanying changing levels of consciousness[1] has led to some striking correlations between such awareness variations, fluctuating emotional tension and the arterial blood oxygen-saturation values, as determined oximetrically.

Recently, in the course of some investigations involving the electroencephalogram, we became interested in observing the psychological effects of a continuously flickering, high-intensity light source (provided by a 'Scophony' stroboscope) on a group of healthy subjects whose peripheral blood oxygen levels were monitored by a technique of discontinuous oximetry[2] recording from the minute vessels of the finger nail fold. In the present study, twenty-five subjects were separately placed in a chair facing the stroboscope lamp, which was situated some twelve inches from their eyes. Flicker was begun at a rate of 3 per sec. and continued for 15 sec., after which an oximetric reading was taken from the ring finger of the left hand. The flicker frequency was then increased to 4 per sec., and a second oximetric reading taken and so on, the flicker rate being increased by regular increments until the individual critical flicker-fusion threshold had been passed. A typical oximetric flicker profile is shown in the accompanying chart. It was found that it made no difference whether the change was made from low to high rates of flicker or vice versa : similarly, no difference in the overall profile occurred if flicker rates were selected at random and the profile completed in a haphazard fashion.



Typical spectroscopic oximetric photic flicker profile from a healthy male subject aged 22 years. Oximetric measurements are in 'reduction time' seconds and are also expressed as percentage equivalent arterial oxygen saturation

In healthy subjects it was regularly noted that slow photic flicker rates between 3 and 8–9 per sec. produced a depression of blood oxygen-saturation values which were at a maximum at frequencies of 4–6 per sec. down to 88·8 per cent oxygen in some cases, while in the range 9–11 per sec. no significant change from the subject's resting values occurred. A second, and similar, anoxæmic trough appeared in the harmonic range 12–17 per sec., again with no change in the resting levels at flicker frequencies of 18–22 per sec. At higher frequencies, a rise in oxygen levels took place to 100·0 per cent oxygen saturation at 22–32 per sec. ; but, on pushing the rate up beyond this, the threshold for flicker fusion was encountered and the oxygen levels fell progressively to their original resting values and remained there.

The widespread influence of regularly intermittent, rhythmic sensory stimulation can be observed from our further demonstration that entirely similar oximetric profiles could be obtained by replacing the flickering light by a relatively low-intensity auditory stimulus modulated to the same frequencies.

The inter-relationships of intermittent retinal stimulation and the emotional state of the human organism have been the subject of numerous neurophysiological and psychological inquiries[2]. The association of simple[4] and flickering[5] photic stimulation and seizures, that is, rapid changes in the levels of awareness, in certain epileptogenic patients has been amply confirmed[6,7]. The correlates of intermittent auditory stimuli in such patients have been rather less widely reported in the literature, but were first noted by Merzjejevskif in 1884[8], and the interesting case of musicogenic epilepsy[9] would seem to belong to this category. The mechanisms, concomitant physiological epiphenomena, including the electroencephalograph, and their applications to more subtle and chronic, and less sudden and severe variations of consciousness are the subjects of investigation in this laboratory, and details of the results will be published elsewhere.

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Steroids exerting a Direct Progestational Effect on the Rabbit Endometrium

In an earlier publication[1], results obtained by inserting certain steroids directly into tied-off segments of the uterine horns of spayed rabbits were reported. It was found that several steroids which on systemic administration have a progestational effect in the rabbit do not have such activity when inserted into the uterus. It was suggested that steroids of this type exert a progestational effect by an indirect mechanism, becoming converted in the body either into progesterone or one of the related steroids which have direct progestational activity.

On the basis of the results reported in 1950, it appeared that the essential criterion for direct progestational activity in the rabbit was a steroid nucleus with a side-chain of at least one carbon atom at C-17. Since then, intra-uterine implantations with 3α 20β pregnanediol have been carried out. This substance, in 20-mgm. doses, had no direct progestational effect in three animals, which responded normally to intra-uterine implants of progesterone in cholesterol. Also allo pregnanediol 3β 20β was shown to be without direct progestational activity. Since pregnanediol has a side-chain at C-17, the concept that all steroids so provided have direct activity must be revised. Comparison of the structural formulæ of the steroids having direct progestational effects, namely, ethisterone, deoxycortone, 17 methyltestosterone, pregnenolone and methyl dihydrotestosterone, with that of pregnanediol, suggests, as a common feature of the active substances, the presence of the ketone group at C-3 or unsaturation between C-4 and -5 or C-5 and -6. Pregnenolone, which lacks a C-3 ketone group, is unsaturated between C-5 and -6; methyl dihydro testosterone, which has no such unsaturation, has a C-3 ketone group; pregnanediol, which was found to lack progestational activity, possesses neither of these two characteristics. On the basis of the recent results with pregnanediol it is therefore suggested that essential criteria for direct progestational activity in the rabbit are the steroid nucleus with a side-chain of at least one carbon atom at C-17, and in addition the presence of the C-3 ketone group or alternatively unsaturation involving C-5.

It is already known that this generalization is valid only for the rabbit, for experiments by Robson and Sharaf[2] in the cat have shown that in this species pregnenolone, ethisterone and methyl testosterone do not have direct progestational activity; and Hooker and Forbes[3], on testing a large number of steroids for progesterone-like effects on the endometrial nuclei of the mouse, were unable to find any substance which shared this effect with progesterone.

Some further experiments with intra-uterine implants of androsterone and dehydro *iso*androsterone may also be reported here, as the earlier results were insufficient to decide conclusively that these two compounds lacked direct progestational activity. As a result of further implantations of 20 mgm. of each of these two substances in several animals which showed a good response to intra-uterine progesterone in cholesterol, it may be stated that androsterone and dehydro *iso*androsterone do not have direct progestational activity in the rabbit.

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Dec. 11.

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Comparisons of Insecticidal Activation

Various substances activate certain insecticides, especially the pyrethrins; that is to say, these substances, though themselves non-toxic, intensify the toxic action of pyrethrins or other insecticides upon insects. However, no attempt seems to have been made up to now to compare activation effects quantitatively. Many methylenedioxyphenyl compounds are good activators, and two preparations containing them have been investigated, namely, (*A*) one containing 80 per cent of (3,4-methylenedioxy-6-propyl benzyl) (butyl) diethylene glycol ether and 20 per cent of related compounds, and (*B*) one containing the *n*-octyl sulphoxide of *iso*safrole. Both these materials were found to activate pyrethrins, allethrin, and γ-benzene hexachloride (BHC) against flour beetles, *Tribolium castaneum*[1]. The relationship between mortality and the concentrations of insecticide and activator has been investigated, using the materials in solution in Shell oil *P*31 (with benzene as an intermediate solvent where necessary): the solutions were applied at fixed deposit by means of a direct spray technique[2]. In addition, an effort has been made to compare quantitatively the in-

tensities with which the two activators activate each insecticide, and with which the different insecticides are activated by each activator.

With the technique used, it appears that probit mortality, Y, is given over wide ranges of concentration by :

$$Y = a + b_1 \log z_1 + c_1 z_2/(c_2 + z_2), \quad (1)$$

where z_1 and z_2 are the insecticide and activator concentrations respectively and b_1, c_1, $c_2 > 0$. The values of a and b_1 depend only on the insecticide, but those of c_1 and c_2 on both the insecticide and the activator.

If a given insecticide is used, and the activating power of one activator relative to another is to be expressed, on the basis of (1), by means of a relative potency, ρ, the value of c_1 must be the same for both activators. This is easily seen, since if z_2 is the concentration of the 'standard' activator and z'_2 that of the 'test', and $z_2 = \rho z'_2$, then the third term of (1) becomes $c_1 z'_2/(c'_2 + z'_2)$, where $c'_2 = c_2/\rho$: the parameter c_1 is unchanged by the transformation. However, the value of c_1 was found to differ according to the activator. For example, using pyrethrins, c_1 was about 3·5 for A and about 6 for B.

Nevertheless, it proved possible to obtain approximate relative potencies for restricted ranges of activator concentration by approximating (1) by

$$Y = a + b_1 \log z_1 + b_2 z_2{}^r, \quad (2)$$

where $0 < r < 1$. Provided that r can be taken as the same for both activators with a given insecticide, a slope-ratio common-zero type of comparison[3] can be made, using the insecticide at a fixed concentration. If z_1 is fixed, for the standard activator we have :

$$Y = C + b_2 z_2{}^r ; \quad (3)$$

and for the test activator :

$$Y = C + b'_2 z'_2{}^r, \quad (4)$$

whence $\rho = (b'_2/b_2)^{1/r}$. It is also possible to compare the intensities with which a given activator activates different insecticides by means of a slope ratio, but here there is no common zero observation, and so the accuracy is greatly reduced. Tables 1 and 2 give some of the relative potencies obtained : the tables indicate that for the particular experimental conditions B is six times as potent as A in activating pyrethrins, and so on.

Table 1. Comparisons of Activators

Insecticide	Activator Standard	Activator Test	r	Relative potency, test/standard
Pyrethrins	A	B	0·85	6·0
Allethrin	A	B	0·5	1·8
BHC	A	B	0·3	15

Table 2. Comparisons of Insecticides

Activator	Insecticide Standard	Insecticide Test	r	Relative potency, test/standard
A	Pyrethrins	Allethrin	0·7	1
A	Pyrethrins	BHC	0·4	0·02

One hypothesis of the mode of physiological action of activators for pyrethrins is that in the absence of an activator the insect detoxifies some of its dose of pyrethrins, and that an activator reduces this detoxification[4]. The form of (1) is such that a concentration z_2 of activator effectively multiplies the insecticide concentration by antilog $[c_1 z_2/b_1(c_2 + z_2)]$. To express the hypothesis more precisely, then, for the particular conditions of test, in the absence of the activator the insect detoxifies a given proportion of a dose of pyrethrins, the proportion being progressively reduced as z_2 increases. The third term of (1) approaches a maximum of c_1 as z_2 increases, which is most simply explained on the assumption that when the concentration of pyrethrins is effectively multiplied by antilog (c_1/b_1), the detoxification is completely suppressed. If this is so, it appears that in the absence of an activator a proportion $[1 - 1/\text{antilog}\,(c_1/b_1)]$ of the dose of pyrethrins is detoxified. This proportion, and therefore c_1, would depend only on the insecticide, and should therefore be independent of the activator used, assuming the different activators of the methylenedioxyphenyl type to act similarly upon a single detoxification system. However, as mentioned above, c_1 differs according to the activator, and hence either the detoxification hypothesis, or the foregoing interpretation of c_1, is incorrect.

This work has formed part of the research programme of the Pest Infestation Laboratory, and this note is published by permission of the Department of Scientific and Industrial Research.

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Dec. 17.

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Molecular Weight of Jute Alpha-Cellulose

Much work has been done on the determination of the molecular weight of cotton and wood celluloses. Staudinger and Feuerstein[1] reported 1,920 as the degree of polymerization of jute cellulose (which corresponds to a molecular weight of 311,040). But Chowdhury and Bardhan[2] obtained 516 ; their value was calculated from Staudinger's equation :

$$\eta_{sp}/C = K_m M, \quad (1)$$

where η_{sp} is the specific viscosity, C the concentration, K_m a constant and M the molecular weight. K_m was taken to be 10×10^{-4}. Since K_m is now accepted as 5×10^{-4}, their figure has to be doubled (that is, the degree of polymerization becomes 1,032).

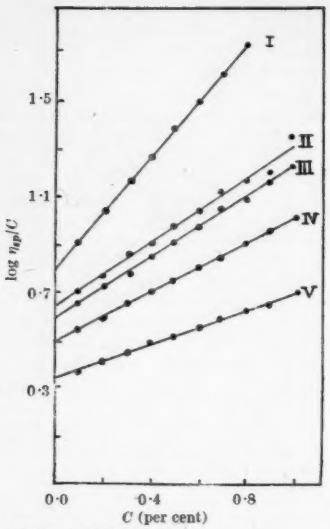
We are reporting here some results for the molecular weight of alpha-cellulose from jute delignified by different methods[3]. The yield of alpha-cellulose is practically the same by all these methods (Table 1).

Table 1

Method of delignification	Alpha-cellulose on bone-dry raw jute
Cross and Bevan	59·99
Sodium chlorite	60·43
Norman and Jenkins	61·15
Chlorine dioxide	60·22

Purified cotton[4] was taken as the standard for comparison. The viscosity measurements were done in British Cotton Industry Research Association standard capillary viscometers. Both the cuprammonium hydroxide and the solution of alpha-cellulose were prepared according to the method of Launer and Wilson[5] with slight modification.

On plotting η_{sp}/C against C for each sample, curves are obtained ; but plotting log η_{sp}/C against C gives straight lines, from which the values of intrinsic



I. Cotton purified
II. α-Cellulose from Cross and Bevan's cellulose chlorite cellulose
III. " " Norman and Jenkins's cellulose
IV. " " chlorine dioxide cellulose
V. " "

viscosity, $[\eta] = Lt(\eta_{sp}/C)C \rightarrow 0$, can be found by extrapolation to zero concentration.

Staudinger's formula (1) with $K_m = 5 \times 10^{-4}$, and C in base molar concentration, has been used here in calculating the molecular weight, the concentration in gm./dl., adopted in determining intrinsic viscosity, being converted into base molar unit. The formula suggested by the testing committee of Industriegemeinschaft Chemiefaser[6] was also tried and found to give more or less the same figures.

The results shown in Table 2 are the mean of four different observations for each sample of alpha-cellulose prepared from the same jute.

The molecular weight of jute alpha-cellulose is different for different methods of delignification, indicating apparently some degradation during delignification, the greatest degradation occurring in the chlorine dioxide method.

Alpha-cellulose was isolated in the above cases with 17·5 per cent caustic soda at room temperature

Table 2

Sample	Intrinsic viscosity ([η] dl./gm.)	Mol. wt.	Degree of polymerization
Cotton purified	6·60	213,840	1,320
α-Cellulose from Cross and Bevan's cellulose	4·47	144,828	894
α-Cellulose from chlorite cellulose	4·10	132,840	820
α-Cellulose from Norman and Jenkins's cellulose	3·09	100,035	618
α-Cellulose from chlorine dioxide cellulose	2·60	84,240	520

Table 3

Sample	Mol. wt.	Degree of polymerization
α-Cellulose from chlorite cellulose with 17·5 per cent caustic soda	132,840	820
α-Cellulose from chlorite cellulose with 9·3 per cent caustic soda	182,250	1,125

by the American Chemical Society method[7] with slight modification. Treatment of jute cellulose with 9·3 per cent (w/w) caustic soda at room temperature also gives alpha-cellulose[8]. The results in Table 3 tend to show that a less degraded product is obtained when a weaker caustic soda is employed.

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Nov. 15.

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"Academic Freedom and Civil Rights"

My name was mentioned in *Nature* of December 22, p. 1053, in connexion with a "reported statement" on academic freedom.

I made no such statement. I would like to emphasize that reports of events twelve thousand miles away are rarely accurate when seen through abbreviated cables. It seemed ironical to me to find that, having defended academic freedom all my life, I am now taken to task for breaking down its foundations. The rule about professors not standing for Parliament is eighty years old and arose out of a quarrel between Hearn and the Council. Hearn evaded the statute by having himself made a dean of the Faculty of Law, and drafted the statute carefully so that he was not a professor. He immediately stood for Parliament again and remained a member of the Legislative Council until his death. No further attempt was made by the Council to prevent him from sitting in Parliament. It has always been regarded as a humorous incident in our history, but the rule has remained on the books ever since.

I am not aware that the rule has ever been formally debated in Council since. I hazard the opinion that it has survived not to curb academic freedom (for professors are perfectly free to express their views either in speeches or in letters to the press, and, in fact, do so) but because it is in practice too difficult for a professor to run his department and to sit in Parliament. The newer universities make great demands on the time of their staff, and so does politics in a growing country. It is almost impossible to do the two tasks at once, as anyone who understands the Australian scene will appreciate. There have been exceptions in other States in the past, but they belonged to more leisured times.

I venture to emphasize that academic freedom is in no danger in Melbourne—indeed, the recent debate in Council (which was so misrepresented by sections of the press) emphasized the fundamental importance of the university being a forum for the discussion of all views.

G. W. Paton
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University of Melbourne.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, May 19

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Dr. Donald Thomson: "Explorations in Arnhem Land".

Monday, May 19—Saturday, May 24

ELECTRICAL ASSOCIATION FOR WOMEN (at Scarborough).—Twenty-seventh Annual Conference.

Tuesday, May 20

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Mrs. Winifred Raphael: "An Enquiry into Joint Consultation—Methods and Findings".

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (in the Chemistry Department, Royal College of Science, Imperial Institute Road, London, S.W.7), at 2.45 p.m.—Annual General Meeting; Sir Herbert Howard: "The Commonwealth Agricultural Bureaux".

PHYSICAL SOCIETY (at the Royal Institution, 21 Albemarle Street, London, W.1), at 3 p.m.—Extraordinary General Meeting; at 3.15 p.m.—Annual General Meeting; at 5 p.m.—Prof. L. F. Bates, F.R.S.: "Some Post-War Developments in Magnetism" (Presidential Address).

UNIVERSITY OF LONDON (at Bedford College for Women, Regent's Park, London, N.W.1), at 5.15 p.m.—Mrs. M. Jefferys: "Aspects of Labour Mobility under Full Employment".*

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5.30 p.m.—Dr. Donald F. Thomson: "Culture Contacts in North Queensland and the Northern Territory of Australia".

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Discussion on "The Teaching of Engineering Economics" (to be opened by Prof. R. O. Kapp).

Tuesday, May 20—Friday, May 23

ILLUMINATING ENGINEERING SOCIETY (at the Grand Hotel, Eastbourne).—Summer Meeting.

Wednesday, May 21

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Mr. R. M. Goody: "A Statistical Model for Water-vapour Absorption"; Mr. B. W. Thompson: "An Essay on the General Circulation of the Atmosphere over South-East Asia and the West Pacific".

ROYAL MICROSCOPICAL SOCIETY (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. Bruno Kisch: "The Electron Microscopic Structure of the Heart Muscle".

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. O. Kratky (Graz): "Investigation on the Size and Shape of Macromolecules and Colloidal Particles by Means of X-Rays".*

Thursday, May 22

BRITISH GLACIOLOGICAL SOCIETY (at Bedford College for Women, Regent's Park, London, N.W.1), at 5.30 p.m.—Prof. G. Manley: "The Snowline in Britain".

Thursday, May 22—Friday, May 23

EUROPEAN ASSOCIATION OF EXPLORATION GEOPHYSICISTS (at Manson House, 26 Portland Place, London, W.1).—Scientific Papers.

Friday, May 23

INSTITUTION OF ELECTRICAL ENGINEERS, UTILIZATION SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. W. F. Cartwright: "The Use of Electricity in a Modern Iron and Steel Works" (Annual Lecture).

TELEVISION SOCIETY (at the Cinematograph Exhibitors' Association, 168 Shaftesbury Avenue, London, W.C.2), at 7 p.m.—Mr. J. J. Billin: "The H.M.V. 21-inch Tube Receiver".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Harold Spencer Jones, F.R.S.: "Continuous Creation".

BIOCHEMICAL SOCIETY (in the Physiology Institute, Newport Road, Cardiff).—Scientific Papers.

Friday, May 23—Saturday, May 24

ASSOCIATION OF UNIVERSITY TEACHERS (in the Stephenson Building, King's College, Claremont Road, Newcastle-upon-Tyne).—Presidential Address; British Student Tuberculosis Foundation; Report of Committee on Selection and Maintenance of Students, etc.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

CHEMICAL ENGINEER (with an honours degree in chemical engineering, some experience in the design and operation of pilot plant, and experience in a branch of the carbonization industry) on the staff of the Divisional Chief Scientist—The Secretary, National Coal Board, South-Eastern Division, Waterloo Crescent, Dover (May 23).

EDUCATIONAL PSYCHOLOGIST—The Director of Education, 5 Portland Square, Carlisle (May 24).

LECTURER IN BOTANY OR ZOOLOGY, and an ASSISTANT, Grade A, IN BOTANY OR ZOOLOGY, at the Municipal College of Technology and Commerce—The Education Officer, Town Hall, Bournemouth (May 24).

LECTURER (graduate with research experience and, preferably, some experience in industry) IN CHEMISTRY, and an ASSISTANT LECTURER, Grade B (honours graduate, or with an equivalent qualification) IN CHEMISTRY—The Principal, Royal Technical College, Peel Park, Salford (May 24).

LECTURER IN MATHEMATICS (honours degree in mathematics is essential) in the Department of Science, Croydon Polytechnic—The Chief Education Officer, Education Office, Katharine Street, Croydon, Surrey (May 24).

RESEARCH ASSISTANTS (with a good honours degree in physics and/or mathematics) for a range of work on electronics, with particular reference to the performance and characteristics of thermionic valves and associated equipment—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (May 24).

SENIOR LECTURER IN ELECTRICAL ENGINEERING, and a TEACHER OF ENGINEERING DRAWING—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (May 27).

DEMONSTRATORS IN THE DEPARTMENT OF ANATOMY—The Registrar, The University, Liverpool (May 28).

ASSISTANT LECTURER IN THE DEPARTMENT OF PSYCHOLOGY—The Registrar, The University, Liverpool (May 29).

LECTURER IN PHYSIOLOGY in the United College, St. Andrews—The Secretary, The University, St. Andrews (May 30).

ASSISTANT LECTURER IN PHYSICS—The Registrar, The University, Sheffield (May 31).

ASSISTANT LECTURER or LECTURER IN METALLURGY, and a RESEARCH DEMONSTRATOR IN METALLURGY—The Registrar, University College, Cathays Park, Cardiff (May 31).

ASSISTANT LECTURERS (2) IN THE DEPARTMENT OF PHYSIOLOGY—The Registrar, The University, Liverpool (May 31).

ASSISTANT LECTURER IN PSYCHOLOGY (with some postgraduate experience in the fields of social or industrial psychology)—The Registrar, The University, Manchester 13 (May 31).

ASSISTANT LECTURER IN ZOOLOGY—The Registrar, University College, Cathays Park, Cardiff (May 31).

LECTURER IN CHEMISTRY—The Secretary, The University, Aberdeen (May 31).

LECTURER IN ELECTRICAL ENGINEERING at the University of Natal, Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 31).

PROBATIONARY ASSISTANT LECTURER IN ENGINEERING, or a LECTURER IN ENGINEERING—The Registrar, University College, Singleton Park, Swansea (May 31).

SCIENTIST, Grade II (with a good University honours degree or equivalent in chemistry or physics, chemical engineering or fuel technology) on the staff of the Director of Scientific Control at London headquarters—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/463 (May 31).

SENIOR LECTURER IN CHEMISTRY, and an ASSISTANT LECTURER IN MATHEMATICS, at Fourah Bay College, Sierra Leone—The Appointments Secretary, Advisory Committee on Colonial Colleges, 15 Victoria Street, London, S.W.1 (May 31).

SENIOR LECTURER IN PHYSICS at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 31).

SOIL CONSERVATION OFFICERS in the Department of Conservation and Extension, Southern Rhodesia—The Secretary, Southern Rhodesia Government, 429 Strand, London, W.C.2 (May 31).

LECTURER IN ORGANIC CHEMISTRY—The Registrar, Queen Mary College, Mile End Road, London, E.1 (June 2).

PROFESSOR OF PHYSICS—The Registrar, University College, Exeter (June 4).

LECTURER or ASSISTANT LECTURER with special qualifications in GREEK PHILOSOPHY AND PHILOSOPHY OF RELIGION, and an ASSISTANT LECTURER (temporary) IN PHILOSOPHY—The Registrar, University College, Aberystwyth (June 7).

RESEARCH OFFICERS (Scientific Officer grade) to work on forage crops and on cytogenetic problems—The Director, Plant Breeding Institute, School of Agriculture, Cambridge (June 7).

ASSISTANT LECTURER IN ELECTRICAL ENGINEERING—The Registrar, College of Technology, Manchester 1 (June 9).

ASSISTANT LECTURER IN ZOOLOGY—The Principal, Royal Holloway College, Englefield Green, Surrey (June 9).

ASSISTANT LECTURERS (2) IN THE DEPARTMENT OF GEOGRAPHY (for one post preference will be given to those having special qualifications in geomorphology, and for the other to those having special qualifications in either economic geography or climatology)—The Registrar, The University, Leeds 2 (June 9).

RESEARCH FELLOWSHIP IN THE DEPARTMENT OF CHEMISTRY, for the investigation of diffusion and flow in porous media with special reference to cellulose and its derivatives—The Secretary, The University, Aberdeen (June 10).

BURSARIES for research in combustion and carbonization, and tenable in the Department of Fuel Technology—The Registrar, The University, Sheffield (June 12).

ASSISTANT LECTURER IN BOTANY at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (June 15).

APPLIED MATHEMATICIAN in the National Physical Laboratory, Pretoria—The South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (Pretoria, June 20).

ASSISTANT IN GEOGRAPHY—The Secretary of University Court, The University, Glasgow (June 30).

READER IN PHYSICAL AND INORGANIC CHEMISTRY, a LECTURER IN PLANT PHYSIOLOGY AND BIOCHEMISTRY, a LECTURER IN ZOOLOGY (preference will be given to an experimental embryologist), a LECTURER IN CHEMISTRY, and a PROTEIN CHEMIST (to form one of a new biophysics group equipped with a Philips electron microscope, a Tiselius electrophoresis apparatus and a preparative ultra-centrifuge), at the University of Adelaide—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (June 30).

SCIENTIFIC ASSISTANT (able to write correct English, and with a knowledge of several modern European languages) for the collation, abstracting and reviewing of biological literature—The Director, Commonwealth Bureau of Plant Breeding and Genetics, School of Agriculture, Cambridge (June 30).

UNITED KINGDOM GAS CORPORATION SCHOLARSHIP—The Registrar, The University, Leeds 2 (June 30).

ORGANIC CHEMISTS (3), a PHYSICAL CHEMIST, PHYSICISTS (2), and METALLURGISTS (2), British Columbia Research Council, University of British Columbia, Vancouver—The Director, B.C. Research Council, British Columbia House, 1 Regent Street, London, S.W.1 (July 15).

PROFESSOR OF THEORETICAL PHYSICS (a specialist in quantum mechanics being desired) in the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 31).

ANALYTICAL CHEMIST in the Government Analyst's Laboratory, Khartoum—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, quoting 'Analytical Chemist 1210'.

ASSISTANT, Grade B (a degree, or equivalent qualification, in metallurgy is essential) for metallurgical subjects to Higher National Certificate standard, with physics to the standard of the Ordinary National Certificate—The Principal, Technical College, Cole Street, Scunthorpe, Lincs.

BIOCHEMIST (with degree in biochemistry, or equivalent, and a good knowledge of hospital work, or of physiology) for Area Laboratory—The Secretary, Westwood Hospital, Beverley, Yorks.

CHEMIST (with honours degree in metallurgy, chemistry or physics, or equivalent qualification, together with experience in a factory or industrial laboratory and of welding of all types) by the Ministry of Supply at Chislehurst, Kent (Ref. F.279/52A), to be responsible, under direction, for (*a*) dealing with specifications and testing of castings, forgings and machined components in alloy steels including armour plate, (*b*) the supervision of inspection of heat treatment processes and investigation of defects and failures, (*c*) general working of X-ray equipment at a test station and welding of armour and other materials in production; and a CHEMIST (with honours degree in chemistry or chemical engineering or equivalent qualification) by the Ministry of Supply at Aldermaston, Berks (Ref. F.28/52A) to assist in the technical control of chemical plant with particular reference to treatment of water supplies and effluents—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

ENTOMOLOGISTS (with a special interest in and general knowledge of the Coleoptera for one post, and a special interest in the Coccidæ and a general knowledge of allied families for the other)—The Director, Commonwealth Institute of Entomology, 41 Queen's Gate, London, S.W.7.

EXPERIMENTAL OFFICERS at R.A.F. Signals Experimental Establishments, to assist in: (1*a*) general experimental work in connexion with design of high power long distance radio telegraph systems or radio communications and radar systems (Ref. D.171/52A), (1*b*) aerial and feeder systems (Ref. D.172/52A), (2) site selection and installation design of large radio receiving transmitting stations, radio telegraph terminal offices, or radio airfield approach and landing aids (Ref. D.173/52A), (3) experimental and development work associated with small electro-mechanical machines for machine telegraph systems (Ref. D.174/52A), (4) development and test of prototype mobile and portable radio and radar installations (Ref. D.175/52A), or (5) engineering trials and investigations of modern automatic telegraph and line equipment (Ref. D.176/52A); Post 1*a* is located at Ruislip, Posts 1*b*, 2, 4 and 5 at Medmenham, and Post 3 at Kidbrooke—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

GRADUATE PHYSICIST as LECTURER IN THE DEPARTMENT OF TEXTILE TECHNOLOGY—The Secretary, Royal Technical College, Glasgow.

HONOURS GRADUATES IN CHEMISTRY or PHYSICS (Scientific Officer and Senior Scientific Officer grades) for research in the ceramic industry—The Director of Research, British Ceramic Research Association, Queens Road, Penkhull, Stoke-on-Trent.

PHYSICISTS at a Ministry of Supply Experimental Establishment near Southend for work connected with out-of-door instrumentation: SCIENTIFIC OFFICERS (Ref. A.146/52A), EXPERIMENTAL PHYSICIST (*a*) with experience of metallurgical techniques, (*b*) for field experimental work (some light engineering experience is desirable), (*c*) for the investigation of explosive phenomena by electronic and/or photographic methods; EXPERIMENTAL OFFICERS (Ref. A.145/52A), (*a*) with interest in electronics as applied to counter circuits and recording of high speed transient phenomena, (*b*) for general experimental work (for some posts an interest in mathematics is desirable)—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

PHYSICISTS AND ELECTRICAL ENGINEERS (Senior Scientific Officer or Scientific Officer grades) at a Ministry of Supply Research Establishment near Sevenoaks: (Ref. A.135/52A) PHYSICIST with experience in electronic circuitry problems for measurement of high speed transients; (Ref. A.136/52A) PHYSICIST or ELECTRICAL ENGINEER with experience in radio communications; (Ref. A.137/52A) PHYSICIST interested in research into spark phenomena and transients; (Ref. A.138/52A) PHYSICIST or ELECTRICAL ENGINEER with knowledge or interest in electronic circuitry for work on airborne electronics—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

PRINCIPAL SCIENTIFIC OFFICERS (Electronic Engineers or Physicists) in the Royal Naval Scientific Service: for one post a knowledge of modern communication theory, mathematical statistics, and audio-frequency equipment would be advantageous, and the successful candidate will be required to undertake advanced study of the properties of conversational speech; for the other posts research experience in high-speed electronic switching, data storage and handling techniques is required; both digital and analogue experience are relevant, and the successful candidates will be required to take charge of teams engaged on the design and development, to prototype stage, of large-scale equipments—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.121/52A.

PRODUCTION CHEMISTS in Royal Ordnance Factories at Irvine, Bishopton, Chorley, Swynnerton, Pembrey, Bridgwater, Thorp Arch, and at Ministry of Supply Headquarters in London, to assist in technical control or administration of explosives and acids manufacture or ammunition filling, including development work—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F.542/51A.

PROFESSOR OF PHYSICS, HEAD OF DEPARTMENT OF PHYSICS, College of Arts and Science, Baghdad, Iraq—The Ministry of Labour and National Service, Technical and Scientific Register (A.8.12), Almack House, 26 King Street, London, S.W.1, quoting A.12/UNE/118/52.

SENIOR SCIENTIFIC OFFICER (with a University degree with first- or second-class honours with chemistry as a principal subject, or equivalent qualification) for the chemical and technical investigations of plant and animal products and assistance in preparation of memoranda, reports and replies to inquiries regarding their production, preparation and marketing (Ref. F.301/52A), and a SCIENTIFIC OFFICER (with a University degree with first- or second-class honours with chemistry as a principal subject, or equivalent qualification) to assist in the duties outlined above (Ref. F.302/52A), in the Colonial Products Advisory Bureau (Plant and Animal), London, S.W.7—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER, to assist in a development programme on the improvement of industrial gas producers as used for furnace firing—The Assistant Secretary (Ref. A.4), British Coal Utilization Research Association, Randalls Road, Leatherhead, Surrey.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Physics Abstracts. Section A of Science Abstracts. Vol. 54, 1951. Pp. xii+1460. (London: Institution of Electrical Engineers, 1951.) [103

Electrical Engineering Abstracts. Section B of Science Abstracts. Vol. 54, 1951. Pp. xii+737. (London: Institution of Electrical Engineers, 1951.) [103

Dove Marine Laboratory, Cullercoats. Report for the Year ending July 31st, 1949. Pp. 65. (Newcastle-upon-Tyne: King's College, 1951.) 5*s*. [113

Department of Scientific and Industrial Research: Food Investigation. Leaflet No. 15: The Commercial Storage of Vegetables. By W. Hugh Smith. Pp. 8. (London: H.M. Stationery Office, 1952.) 6*d*. net. [113

Geography in the Secondary School: with Special Reference to the Secondary Modern School. A Report prepared by Dr. E. W. H. Briault and D. W. Shave. Pp. 36. (Sheffield: Geographical Association, 1952.) 2*s*. [113

Metallurgical Abstracts (General and Non-Ferrous.) Vol. 17, 1949–50. Editor: N. B. Vaughan. Pp. viii+1152. (London: Institute of Metals, 1950.) 60*s*. [123

University of Birmingham. Report of the Vice-Chancellor and Principal to the Council for the Calendar Year 1950. Pp. 79+10 plates. (Birmingham: The University, 1952.) [123

Contributions from the Dunsink Observatory. No. 2: Photoelectric Recording of Stellar Occultations. By H. E. Butler. Pp. 4+1 plate. No. 3: A Study of the Profile of the Hydrogen $H\alpha$ Line in the Spectra of Solar Prominences. By Mary T. Conway. Pp. 9. No. 4: Observations of Stellar Scintillation. By H. E. Butler. Pp. 20+10 plates. (Dunsink: Dunsink Observatory, 1951–1952.) [123

Other Countries

Fieldiana. Geology, Vol. 11, No. 5: Late Devonian Fresh-Water Fishes from the Western United States. By Robert H. Denison. Pp. 219–262. 75 cents. Zoology, Vol. 32, No. 9: Birds from Liberia, with a Discussion of Barriers between Upper and Lower Guinea Subspecies. By Austin L. Rand. Pp. 559–654. 1 dollar. Zoology, Vol. 32, No. 10: A Revision of the North American and European Staphylinid Beetles of the Subtribe Gyrophaenae (Aleocharinae, Bolitocharini). By Charles H. Seevers. Pp. 655–672. 1.25 dollars. (Chicago: Chicago Natural History Museum, 1951.) [103

Transactions of the American Philosophical Society, New Series. Vol. 41, Part 4: The Comédie Française 1701–1774; Plays, Actors, Spectators, Finances. By Prof. H. Carrington Lancaster. Pp. 593–849. (Philadelphia: American Philosophical Society, 1951.) 2.50 dollars. [103

Report of the Secretary of the Smithsonian Institution and Financial Report of the Executive Committee of the Board of Regents for the Year ended June 30, 1951. (Publication 4056.) Pp. ix+160. (Washington, D.C.: Government Printing Office, 1952.) 55 cents. [103

Cérémonie commémorative en l'honneur du centenaire de la naissance du Professeur Arsène d'Arsonval 1851–1940. Pp. 42+7 plates. (Paris: Union des Associations scientifiques et Industrielles Françaises, 1951.) [103

Report and Accounts of the National Botanic Gardens of South Africa, and the Karoo Garden, for the Year ending 31st December 1951. Pp. 20. (Newlands, Cape: National Botanic Gardens of South Africa, 1952). [103

Institut des Parcs Nationaux du Congo Belge. Exploration des Parcs Nationaux du Congo Belge, Mission H. Hediger—J. Verschuren (1948). Fascicule 1: Observations sur la psychologie animale dans les Parcs Nationaux du Congo Belge. Par H. Hediger. Pp. 194. (Bruxelles: Institut des Parcs Nationaux du Congo Belge, 1951.) [103

You will like Geometry: a Guide Book for the Illinois Institute of Technology Geometry Exhibition at the Museum of Science and Industry. By Dr. Karl Menger. Pp. ii+34. (Chicago: Illinois Institute of Technology, 1952.) [123